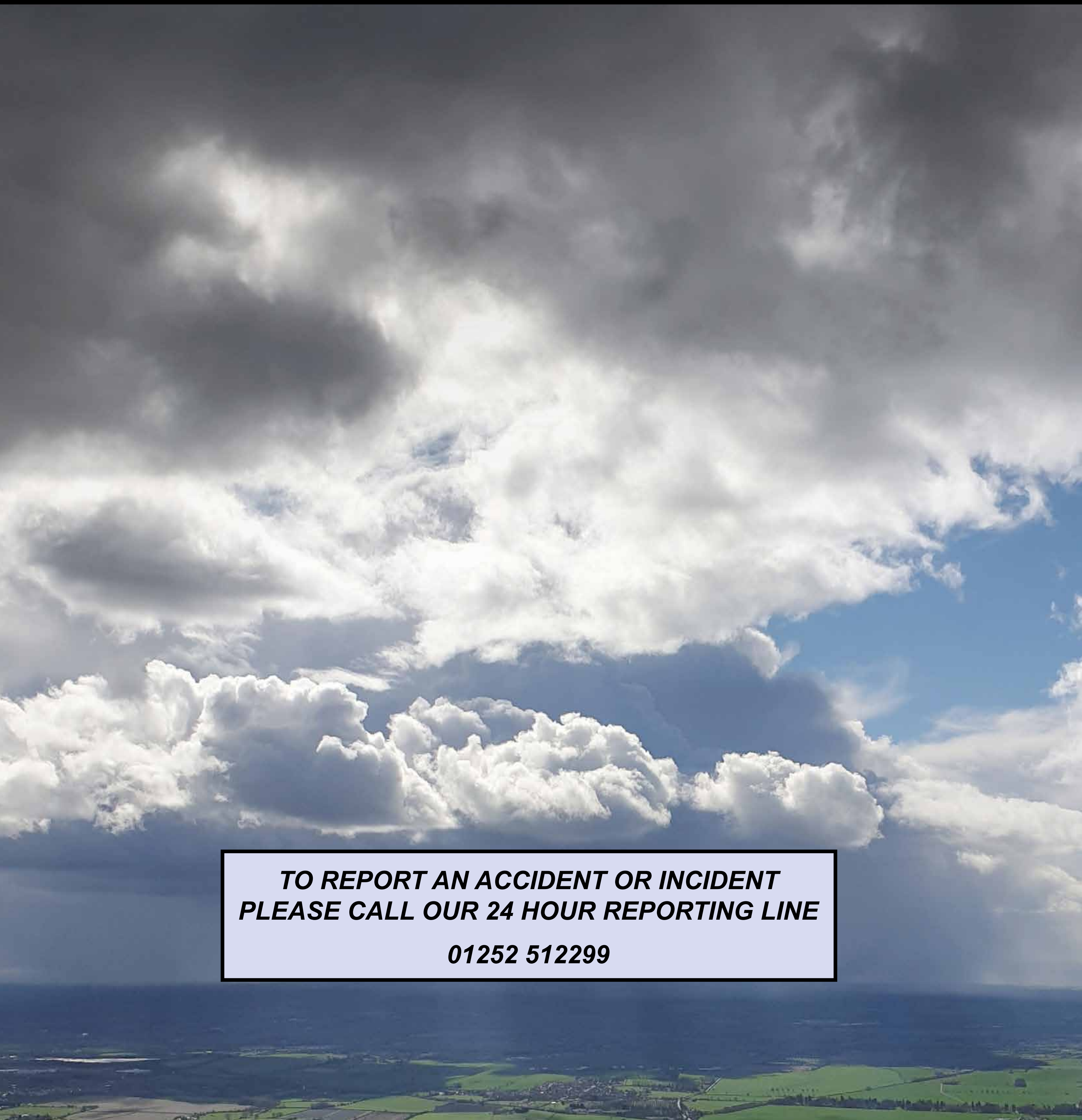
AAIB
Air Accidents Investigation Branch

AAIB Bulletin 12/2021



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The sole objective of the investigation of an accident or incident under these Regulations is the prevention of future accidents and incidents. It is not the purpose of such an investigation to apportion blame or liability.

Accordingly, it is inappropriate that AAIB reports should be used to assign fault or blame or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

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This bulletin contains facts which have been determined up to the time of compilation.

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MISCELLANEOUS

ADDENDA and CORRECTIONS

None

(ALL TIMES IN THIS BULLETIN ARE UTC)

AAIB Field Investigation Reports

A Field Investigation is an independent investigation in which AAIB investigators collect, record and analyse evidence.

The process may include, attending the scene of the accident or serious incident; interviewing witnesses; reviewing documents, procedures and practices; examining aircraft wreckage or components; and analysing recorded data.

The investigation, which can take a number of months to complete, will conclude with a published report.

ACCIDENT

Aircraft Type and Registration:	Cessna FRA150L, Aerobat, G-CIIR
No & Type of Engines:	1 Rolls-Royce Continental O-240-A piston engine
Year of Manufacture:	1973 (Serial no: 187)
Date & Time (UTC):	11 October 2020 at 1342 hrs
Location:	Troutbeck Airfield, Cumbria
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Fatal) Passengers - N/A
Nature of Damage:	Destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	44 years
Commander's Flying Experience:	69 hours (of which 52 were on type) Last 90 days - 3 hours Last 28 days - 2 hours
Information Source:	Field Investigation

Synopsis

G-CIIR landed at Troutbeck Airfield with its pilot and a passenger without the required permission. As the conditions on the day meant the aircraft's takeoff performance from Troutbeck would be marginal, the airfield owner instructed the pilot to depart solo in order to improve the aircraft's performance by reducing its takeoff weight. On the subsequent takeoff the aircraft was seen to depart controlled flight seconds after getting airborne and strike the ground. The pilot was fatally injured.

The investigation identified a number of shortcomings with the preparation for the flight that contributed to the accident.

History of the flight

Background information

The pilot and his passenger planned to fly in his Cessna FRA150L Aerobat (C150), registration G-CIIR, from Retford (Gamston) Airport, Nottinghamshire, where it was based, to Troutbeck Airfield, near Penrith, Cumbria. En route, they planned to meet a friend at Netherthorpe Airfield, South Yorkshire, who had a Maule M7 aircraft (M7) and who would fly to Troutbeck about five minutes ahead of them. Another M7 was due to join them at Troutbeck, flying direct from Auchinleck, near Prestwick Airport, South Ayrshire.

Prior to departing Gamston, the pilot of G-CIIR requested the aircraft's fuel tanks *"were brimmed"* by the refuelers, meaning he wanted them full. G-CIIR then flew to Netherthorpe and landed on grass Runway 36. The M7 landed about 10 minutes later. The pilot of G-CIIR had not obtained the Prior Permission Required (PPR) to land at Netherthorpe before departure from Gamston. The M7 pilot did not require PPR as he was a member of the resident flying club and had an aircraft based there.

After about 50 minutes, the M7 took off from Netherthorpe followed about five minutes later by G-CIIR, at about 1125 hrs. The two aircraft then flew up to Cumbria.

Given the M7's faster cruising speed, and the pilot of G-CIIR's wish to fly a less direct route over the Lake District, the M7 landed at Troutbeck first at about 1235 hrs. At the time grass Runway 36 was in use and the wind was from 360° at about 10 kt. As the runway was "sludgy", the M7 pilot tried to call the pilot of G-CIIR on his mobile phone, to advise him of the runway state. However, he could not "positively remember" if he spoke to the pilot.

After the M7 had shut down, its pilot met the airfield's owner outside the airfield's hangar. About 10 to 15 minutes later, while they were in conversation, G-CIIR came into view. Given the distance, the airfield owner initially thought it was an Aviat Husky[1] or another M7. However, when it was overhead, he realised it was a C150, an aircraft that he was not content to operate into Troutbeck. He ran into the hangar to get his hand-held transceiver and made repeated calls on 'SafetyCom' frequency[2], 135.480 MHz, to try and ascertain what the pilot's intentions were, but there was no response. G-CIIR then made an uneventful descent, approach and landing, and taxied in and parked about 80 m from the hangar. Neither pilot had obtained PPR directly from the airfield owner to land at Troutbeck. However, the M7 pilot believed he had PPR by proxy from the Auchinleck M7 pilot, who had phoned the airfield owner that morning asking for PPR and saying that the M7 pilot was planning on visiting too.

The airfield owner was "very cross" with the M7 pilot, as he had made no mention that a C150 was visiting with him, adding that it was "not appropriate for one to land here in the conditions". After G-CIIR had vacated the runway, the M7 pilot gesticulated to indicate where to taxi and park as the ground was rough and boggy, but the accident pilot misunderstood and parked in an area of boggy ground. After G-CIIR had shutdown, the M7 pilot went to speak to the pilot before he and his passenger went to the hangar. During this conversation, which was recorded by a video camera that the pilot had mounted on the underside of the aircraft's right wing, the pilot referred to the flight from Netherthorpe as being "VERY STRESSFUL". However, he did not elaborate as to what aspects of the fight may have caused concern. The passenger later commented that this was due to the radio being intermittent because of the terrain, having to climb and descend to avoid clouds and trying to keep up with the M7. The M7 pilot then advised G-CIIR's pilot that the airfield owner was dissatisfied that PPR had not been requested, and that the runway's condition was not

Footnote

[1] An Aviat Husky is a tandem two-seat, high-wing short takeoff and landing (STOL) capable aircraft.

[2] SafetyCom is a common traffic advisory frequency for use at aerodromes that do not have an assigned frequency. Aircraft should announce their position and intentions at the normal points in the circuit.

suitable for operating a C150. The M7 pilot then said that he (the M7 pilot) should probably take the passenger back to Gamston in his M7, if not all of them. The pilot replied "NO, NO WE'LL GET OUT EASILY", and the recording ended shortly afterwards.

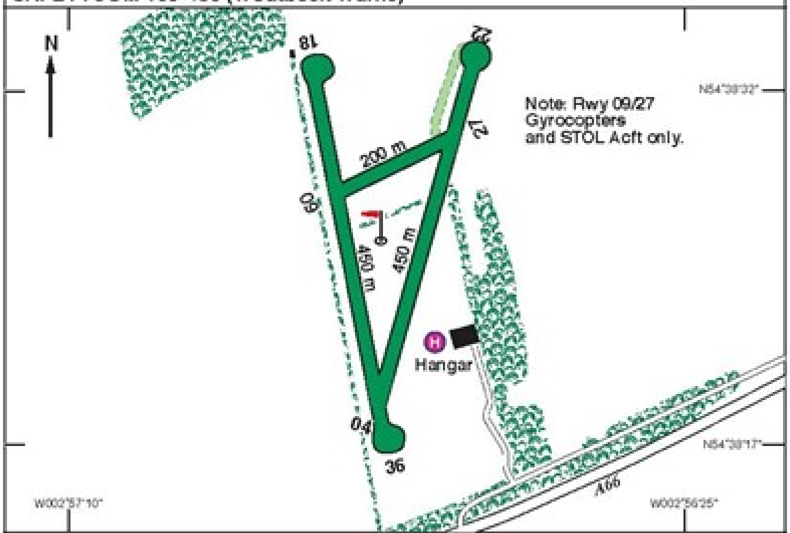
At the hangar the pilot and his passenger met the airfield owner who was annoyed with them and repeated that a C150 should not have landed there in the conditions. The pilot was apologetic, saying he thought someone had phoned on his behalf to ask for PPR.

Given the airfield owner's concerns about a C150 operating from Troutbeck, he instructed G-CIIR's pilot to depart solo, with his passenger departing in the M7. He added that the pilot was to use the full length of Runway 36 to ensure all the Takeoff Distance Available (TODA) was used. This would entail a backtrack of Runway 36 from the intersection of Runway 04 before starting the takeoff roll (Figure 1); the pilot agreed. The airfield owner then had to leave, but before doing so he told the M7 pilot to ensure that he took the passenger back to Gamston and that G-CIIR used the full length of the runway.

N54 38.42 W002 56.78 **TROUTBECK/KESWICK** 984ft AMSL

6.9 nm E of Keswick (Cumbria).

SAFETYCOM 135·480 (Troutbeck Traffic)



Rwy	Dim(m)	Surface	TORA(m)	LDA(m)	Lighting
04/22	450x12	Grass	Unlicensed		Nil
18/36	450x12	Grass	Unlicensed		Nil
09/27*	200x12	Grass	Unlicensed		Nil

*Rwy 09/27 Gyrocopters and STOL aircraft only.

Op hrs: PPR. SR-SS

Landing Fee: Donation to Help for Heroes. Overnight parking available

Customs: Nil. **Hangarage:** Available. **Maintenance:** Nil.

Remarks: Operated by [redacted] Cumbria. CA11 0XG.
Strictly PPR. Pilots welcome with PPR and at own risk.
Camping/Glamping both available on AD.

Figure 1

Plate of Troutbeck Airfield - © Pooleys

Both pilots walked the runway to discuss the airfield owner's instructions, but they did not go to the threshold of Runway 36. Due to the surface condition and the positive gradient from the threshold to the intersection with Runway 04, G-CIIR's pilot said he would go down about halfway from the intersection to the threshold before starting the takeoff roll; the M7 pilot accepted this.

The accident flight

G-CIIR's pilot started his aircraft first for the return to Gamston but, due to the condition of the ground where he had parked, he had difficulty taxiing out. He was assisted by the M7 pilot who leant on the tailplane to take the weight off the nosewheel and pushed the aircraft to help it move.

G-CIIR was seen to taxi along Runway 22 and, as it got to the intersection with Runway 36, turn right onto Runway 36. Its engine was heard to accelerate to full power and the aircraft commenced the takeoff roll. The M7 pilot said that the engine sounded normal and G-CIIR quickly became airborne. This coincided with the M7 pilot starting to record a video of the aircraft using his mobile phone. He estimated the wind was from about 020-030° at 6 kt. Given the short time it took G-CIIR to taxi out and commence the takeoff roll, he believed the pilot did not have time to perform his engine power checks and pre-takeoff checks.

Once airborne, the aircraft was seen to drift left off the side of the runway, yawing left with its pitch angle increasing. It appeared the pilot then started a left turn during which the left wing dropped and the aircraft entered a near vertical dive from about 50 ft agl, before striking the ground in an adjacent field. The aircraft came to rest on its nose in a vertical attitude, having been airborne for just over 10 seconds.

As G-CIIR entered the near vertical dive, the M7 pilot and passenger realised that it was going to strike the ground and started to run towards it. Prior to reaching the aircraft they rang the emergency services before proceeding to it to help the pilot. As they approached the aircraft there was smoke coming from the engine, which soon dissipated. The M7 pilot found the pilot hanging by his lap straps unconscious and not breathing. He believed the pilot did not have his shoulder harness secured. Smelling fuel and seeing some emanating from a hole in the aircraft's right wing tank, he was keen to extricate the pilot in case the aircraft caught fire.

The pilot was subsequently removed from the aircraft with the assistance of the passenger and another witness. As they did this, the aircraft toppled over onto its back, coming to rest inverted. They put the pilot on the aircraft's inverted wing and, with the assistance of the emergency service on the phone, gave the pilot first aid.

Paramedics, local RFFS and police were in attendance about 10 to 15 minutes after the accident and attended to the pilot. An air ambulance arrived soon thereafter. However, the pilot had sustained fatal injuries.

Accident site

The aircraft hit waterlogged soft ground about 60 m from a conifer plantation. Marks on the ground showed that the aircraft hit the ground near vertical with the left wingtip striking the ground first. This was confirmed by the damage to the nose of the aircraft and the leading edges of the wings (Figure 2). The propeller had lifted out a divot and the spinner and engine cowl had made a hole in the soil about 0.45 m deep which had filled with water and a small amount of oil leaking from the engine.

Figure 2
G-CIIR accident site

The engine had been pushed rearwards distorting its firewall and severely disrupting the rudder pedals, instrument panel and surrounding components. The nose section of the aircraft had been shortened by approximately 0.75 m. The fuel selector was in the ON position and the battery master switch, although distorted, appeared to be in the OFF position. The cabin doors remained attached but had opened in the impact. The windscreen frame and instrument panel glare shield were severely distorted, and the windscreen and roof transparencies had fragmented. Some of the personal items within the aircraft had fallen out onto the ground. The left and right seat safety harnesses were loose; the pilot's harness was reported as being found undone by the first responders when they arrived.

The nose landing gear was severely displaced and had bent rearwards, and its wheel fairing had detached. The main wheels and fairings were intact but were heavily contaminated with mud (Figure 3).

Figure 3
Left and right mainwheel mud contamination (aircraft inverted)

Of note, the right main wheel brake appeared to be binding whilst the left mainwheel was free to rotate.

The underside of the fuselage was heavily mud-spattered, and the underside of the tailplane was also contaminated but to a lesser extent.

Fuel had leaked from the right fuel tank leaving approximately 5 litres. The left tank appeared undamaged and contained approximately 26 litres. A total of 31 litres was extracted during the aircraft recovery. There was no fire within or around the aircraft pre- or post-impact.

The pilot's checklist was found open at the '*AFTER START, TAXYING and POWER*' page with mud and scrape marks on it. The '*PRE-TAKE OFF CHECKS – VITAL ACTIONS*' were on the following page. Other pages were in a clean condition.

Accident pilot's experience

The accident pilot completed his PPL(A) Licence Skills Test (LST) on 30 July 2020, and his licence was issued by the CAA on 27 August 2020. Bar the flights to Troutbeck on the day of the accident, he had flown two hours since his LST.

On 8 August 2020 the accident pilot flew G-CIIR from Gamston into the M7 pilot's private grass airstrip, which is 18 nm south-west, prior to his licence being issued by the CAA[3]. The airstrip is orientated approximately east/west and has about 330 m of Take Off Run Available (TORA), with trees and residential houses in the undershoot and overshoot.

When the accident pilot asked his supervising instructor, via a text message, if he could fly there, the instructor assumed he was going there as a passenger with the M7 pilot and

Footnote

[3] After a pilot has passed his LST, but before his licence is issued by the CAA, any solo flying is to be supervised by the pilot's flying school, as if he was still a student. See the following link for more details: https://www.caa.co.uk/Flights-after-completing-a-skill-test.aspx

responded "Go for it". However, the pilot planned to fly himself there in G-CIIR. Prior to departing Gamston, another instructor[4] heard on the radio that this flight was preparing to takeoff and, knowing the airstrip was not suitable for a C150, was surprised to hear this. He tried to phone the pilot to stop him from going but got no reply. He therefore took it upon himself to drive to the airstrip, a distance of about 28 nm (approximately 45 minutes).

The instructor arrived just before G-CIIR landed. After the pilot had landed, the instructor chastised him and made it quite clear that he had driven over because he was completely dismayed that the pilot had opted to operate a C150 into this airstrip. The instructor told him that the airstrip was not suitable for a C150, whatever the pilot's experience, and suggested that a more experienced pilot fly the aircraft out of the airstrip. He also made his feelings known to the M7 pilot. However, the accident pilot subsequently flew G-CIIR out contrary to the instructor's advice.

A few days later the instructor spoke to the pilot and reiterated his concerns to him. He discussed the performance issues and hazards of operating his aircraft into such an airstrip. He also spoke at length about the type of flying he should be doing to gain experience with his new licence; it did not include any grass or performance limiting airfields.

Comments from others involved

Maule M7 pilot

The M7 pilot stated that he was aware the accident pilot had flown into Netherthorpe on a number of occasions and did not remind him to ensure he obtained PPR. With regards to PPR for Troutbeck, the accident pilot messaged the M7 pilot before he departed Gamston asking whether the airfield owner would "REQUIRE A CALL IN ADVANCE?" to which the M7 pilot replied "CALL PROBABLY GOOD BUT NOT ESSENTIAL."

The M7 pilot added that during the approach and landing at Troutbeck he transmitted on the UK's microlight airfield frequency (129.830 MHz) and believes the accident pilot did the same.

Airfield owner

The airfield owner stated that he prefers requests for PPR the day before an arrival. This allows him to check that a pilot has the airfield's plates and appropriate short airstrip experience. He also checks the aircraft type they are flying to ensure it is a "low energy aircraft", like a microlight or a STOL capable aircraft, such as an M7 or Piper Super Cub. However, he instructs pilots to call before they takeoff so he can inform them of the current weather conditions, what the wind is and to advise the most suitable runway to use. He also advises them where to park and, in soft ground conditions, where not to park. If he has any doubt about an aircraft type or a pilot's experience, he will not permit them to visit; this is something he has done before.

Footnote

4 This instructor had flown with the accident pilot early in his training but not since.

The accident pilot had previously visited Troutbeck in G-CIIR, on 25 May 2020, with the M7 pilot who flew in a Super Cub. On this occasion the accident pilot was conducting a solo crosscountry flight prior to completing his PPL(A) LST. The M7 pilot requested PPR from the airfield owner, adding that he was bringing a friend, but the airfield owner was not aware of what type of aircraft he would be arriving in. Having known the M7 pilot for some time, he assumed the other pilot and the aircraft would be capable of operating into Troutbeck. However, the airfield owner was "astounded" to find out, while talking to G-CIIR's pilot, that he was a student pilot. Had the M7 pilot mentioned this when he phoned up, the owner would "most certainly not have allowed him to land". He stated that he would not have given him PPR on the day of the accident due to his lack of experience and the poor ground conditions at the time.

On the morning of 11 October 2020, he received two calls for PPR of which one was from the pilot based at Auchinleck, near Prestwick Airport, who was known to the M7 pilot and was flying in another M7. The Auchinleck pilot asked for PPR and mentioned that the M7 pilot was planning on coming too. However, he made no mention of another aircraft accompanying him. The airfield owner did not try to contact the M7 pilot as he assumed he would be airborne. This was a concern to him because, while the airfield was pretty firm but soggy, there were some wet areas that pilots needed to be made aware of before they arrived, as he didn't want them taxiing too far off the runway into them.

The accident pilot's instructor

The accident pilot purchased G-CIIR in June 2019 when he was part way through training for his PPL(A). Thereafter he flew the rest of the syllabus in it.

One of the accident pilot's instructors, who flew and supervised most of his training flights after he had purchased G-CIIR, stated that during some of the first flights he flew with him he had a habit of not wearing his shoulder straps. From the outset the instructor asked him to put them on, which he reluctantly did. When debriefed on this, the instructor told him firmly that he would not fly with him unless he wore them.

The same instructor described the accident pilot as a "good solid average pilot", though he could be "a bit hit and miss at times". He was also "not the most consistent student". He described him as one of the "more aggressive, pushy students" at times. He added that during some of the first few lessons they flew together these attributes gave him cause to "reel him in" at times and he had to explain to him what was acceptable and what was not. He added that he had to be quite firm with him at times.

He authorised the cross-country flight to Troutbeck on 25 May 2020 as he felt his ability was up to it, his attitude had "turned a new leaf" and he was progressing well through the course[5]. Additionally, he felt the conditions were suitable on the day to go into a "500 m strip". However, he didn't ask to see his performance calculations, though it was expected

Footnote

[5] Article 209 of The Air Navigation Order 2016 states that the training organisation needs to check that an aerodrome used by a student pilot is suitable and, if an unlicensed aerodrome is being used, they are required to conduct an assessment of the suitability and any hazards with operating from/to that aerodrome.

that students would do them when visiting a new airfield. At the end of the briefing the pilot was reminded to obtain PPR, though the instructor did not check this had been done.

Aircraft information

General

The C150 is a two-seat, all-metal, high-wing monoplane with fixed tricycle landing gear. It is fitted with a flat-four cylinder horizontally opposed normally aspirated piston engine driving a two-bladed fixed-pitch propeller. Fuel is contained in rigid tanks within the left and right wings. An ON-OFF fuel selector is fitted on the cockpit floor and when in the ON position fuel is drawn equally from each tank. It has conventional mechanical flying controls and electrically driven flaps. The flaps are operated by a spring-loaded paddle switch which self-centres on release after the chosen flap position is achieved. A pitch trim tab is fitted on the trailing edge of the right elevator and is controlled by a hand wheel in the centre console of the instrument panel. A pneumatic stall warning device is fitted within the leading edge of the left wing. It consists of a small rectangular orifice positioned in the region where a negative pressure develops with the onset of a wing stall. The negative pressure creates a vacuum, via a tube within the wing leading edge, which causes a small reed to vibrate producing an audible note in a horn situated in the cockpit near to the pilot. The main wheels are fitted with hydraulic disc brakes operated by articulated toe pads on the rudder pedals. Four-point adjustable safety harnesses are fitted for the left and right seat occupants.

G-CIIR

The Airworthiness Review Certificate (ARC) was valid until 27 November 20 and its annual inspection was also due at that date.

The aircraft's flight manual stated that normal takeoffs are performed with flaps retracted. Flaps 10 is reserved for minimum ground runs or for takeoffs from soft or rough fields with no obstacles ahead.

The aircraft's flight manual stated that:

> *'The stall warning horn produces a steady signal…4 to 8.5 kts…before the actual stall is reached and remains on until the airplane flight attitude is changed.'*

It added that stall characteristics are conventional with flaps up and down. Slight buffeting may occur just before the stall with flaps down.

Table 1 shows the calculated takeoff and landing weights for the series of flights up to the accident flight.

	Gamston to Netherthorpe	Netherthorpe to Troutbeck	Troutbeck to Gamston
Aircraft Basic Weight	1,212.62	1,212.62	1,212.62
Fuel at start up	156 (26 US Gall)	148 (24.67 US Gall)	82 (13.73 US Gall)
Pilot	176[6]	176	176
Passenger	132	132	N/A
Baggage	9	9	9
Takeoff Weight	**1,685.62**	**1,677.62**	**1,479.62**
Fuel at shutdown	148	82	N/A
Landing Weight	**1,677.62**	**1,611.62**	N/A

Table 1

G-CIIR takeoff and landing weight calculations
(Weights in Pounds)

The calculated takeoff weights for the takeoffs from Gamston and Netherthorpe were 1,685.62 lb and 1,677.62 lb respectively. The calculated landing weight at Netherthorpe was 1,677.62 lb. The aircraft's maximum authorised weight is 1,650 lb (750 kg).

The calculated takeoff weight for the aircraft on the accident flight was 1,479.62 lb. The CG on the accident flight was calculated to be 847 mm aft of datum, within the permitted range of 840 to 930 mm aft of datum.

Meteorology

An aftercast provided by the Met Office for the day of the accident stated that there was a ridge of high pressure over the UK, leading to generally settled conditions.

The METARs for Doncaster Sheffield Airport, 11 nm north-east of Netherthorpe, indicated that there was good visibility with SCATTERED clouds at 2,600 ft aal, and a wind from 340° at 14 kt at 1050 hrs, and from 330° at 14 kt at 1120 hrs.

The conditions at Troutbeck were likely to have been good visibility with SCATTERED cloud around 3,500 ft amsl with a light wind from the north-west. The atmospheric pressure was 1027 hPa. The M7 pilot stated that at the time GCIIR landed the wind was from 360° at about 10 kt.

Video evidence of the airfield's windsock suggested that at the time of the accident the wind varied between 330° and 350° at about 10 kt. There was no evidence of any wind gusts.

Footnote

6 Pilot's naked weight as recorded at the post-mortem examination.

Airfield information

Retford (Gamston) Airport

G-CIIR was based at Retford (Gamston) Airport. It has an asphalt runway orientated 03/21 which has a Take off Run Available (TORA) of 1,199 m.

Netherthorpe Airfield

Netherthorpe Airfield has two grass runways oriented 06/24 and 18/36. Runway 36 has a Landing Distance Available (LDA) of 308 m and a TORA of 361 m.

The airfield is '*Strictly PPR by phone. Inexperienced pilots are to phone for advice prior to arrival and contact a member of flying staff before departure'.*

Troutbeck Airfield

Troutbeck Airfield has three grass runways oriented 18/36, 04/22 and 09/27 (Figure 1). Runway 36 is a 450 m grass runway. The runway has a positive gradient of about 3.3% from the threshold of Runway 36 to just after the intersection with Runway 04. Thereafter, it has a negative gradient. The elevation is approximately the same at the threshold of Runway 36 and Runway 18. Runway 36 is approximately 320 m long from the intersection of Runway 04.

Runway 36 has a gradient of about +0.5% over its full length. This is based on the threshold being at 290 ft amsl and the end being around 298 ft amsl. From the threshold of Runway 04, the slope along the remainder of Runway 36 is negligible (albeit slightly negative; 2 ft over 320 m). To the left of the extended centreline of Runway 36, on slightly higher ground, is a conifer plantation (Figure 4).

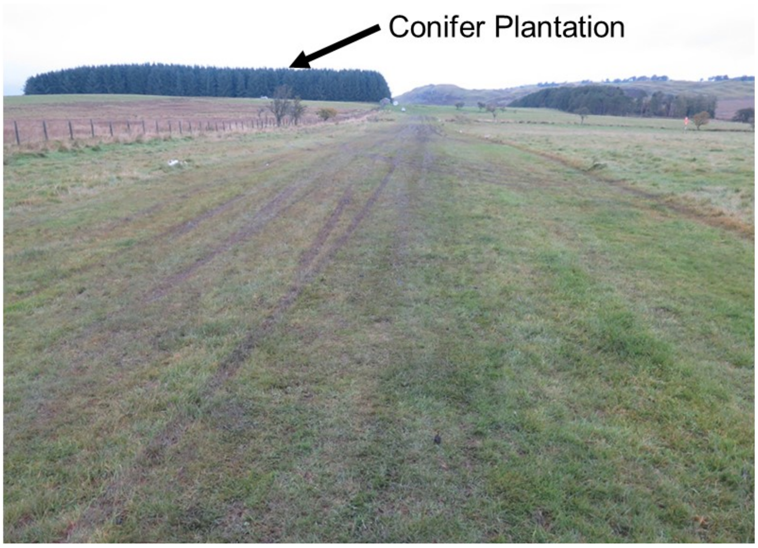


Figure 4

View down Runway 36 showing conifer plantation

About halfway down Runway 36, there is a limestone soakaway, to a drain that runs lengthwise under the runway.

The windsock situated in the middle of the three runways is a 15 kt windsock. This means that it flies horizontally in a wind of 15 kt or greater.

As stated in Figure 1, Troutbeck airfield is '***Strictly PPR***' and the SafetyCom frequency (134.480 MHz) is to be used for RTF communications.

Recorded information

Sources of recorded information

The video and audio soundtrack of G-CIIR, captured by the M7 pilot on his mobile phone, started just before the aircraft became airborne, and the aircraft remained in camera view until shortly before it struck the ground. The footage included the airfield's windsock, which was positioned about 60 m from where the aircraft had taken off.

At 1342:25 hrs, a secondary radar return was recorded for G-CIIR. The radar-derived position was near to where the aircraft struck the ground. Radar data was also available for the aircraft's two previous flights on the day of the accident. Video and audio footage of these flights was captured by a camera that the pilot had attached to the underside of the aircraft's right wing, which captured a near 360° view. After landing at Troutbeck, a conversation between the pilots of G-CIIR and the M7 was recorded. The camera was not operating during the accident flight.

Accident flight

As the video footage of the takeoff started, a light-coloured dust-like cloud could be seen near to the runway behind G-CIIR (Figure 5), which then rapidly dissipated. Very shortly afterwards, G-CIIR lifted off at which point the aircraft yawed to the left whilst also briefly banking to the left (Figure 6), before the wings then levelled. The aircraft's track over the ground was estimated to be approximately 20° to the left of the extended centreline of the runway, which placed the aircraft on a course towards the conifer plantation.

During the next few seconds, the aircraft was observed to climb gradually whilst maintaining a predominantly wings level attitude heading towards the conifer plantation, but as it reached a height of about 50 ft agl, the aircraft proceeded to roll quickly to the left whilst also starting to pitch nose-down whilst descending (Figure 7). The final image of the aircraft (Figure 8), captured less than two seconds later, showed the aircraft's nose was 20° below the horizon and the bank angle had reached nearly 90°. A sound consistent with the aircraft striking the ground was recorded 1.6 seconds later, which coincided with the sound of the engine stopping. The estimated elapsed time from the aircraft becoming airborne to it striking the ground was just over 10 seconds.

During the recording, G-CIIR's engine could be heard operating. There was no evidence of a problem, such as a misfire, and analysis of the audio spectrum showed that the engine speed was consistent with that expected during takeoff.

It was not possible to determine the position of the aircraft's flaps or its control surfaces from the video recording as the resolution was not sufficient.

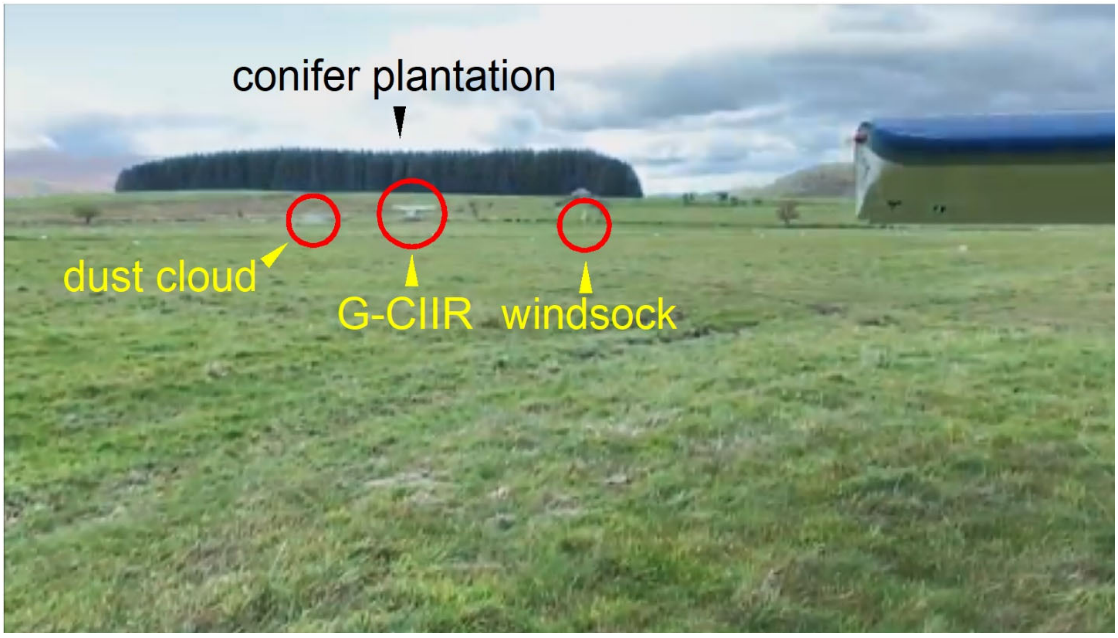


Figure 5
Image of G-CIIR shortly before takeoff

Figure 6
Aircraft yawing and turning left after takeoff

Figure 7
Aircraft banks rapidly to the left whilst starting to descend

Figure 8
Image of aircraft before striking the ground

Previous takeoff distances

At Gamston asphalt Runway 03, the flaps were selected UP and a rolling takeoff was made. The takeoff run distance was about 250 m and at takeoff the airspeed was estimated to have been 70 KIAS.

At Netherthorpe grass Runway 36, the pilot used a short field takeoff technique (full engine power prior to releasing brakes) with FLAPS 10 selected. The takeoff run was about 200 m and the airspeed at takeoff was estimated to have been 63 KIAS.

The video footage showed that at Troutbeck the aircraft had lifted off about 130 m from the upwind end of Runway 36. Based on the witness evidence of where the pilot started the takeoff roll, this equated to a takeoff roll of about 230 m.

Aircraft examination

The aircraft was recovered to the AAIB hangar for further examination.

Airframe

The nose section of the aircraft and engine bay was compressed and had displaced the firewall into the cockpit area. As a result, the flying control linkages to both hand yokes and rudder pedals were displaced and jammed. Both flight control yokes were broken and had detached from their shafts. Most of the instruments had remained in place although many were damaged. No meaningful information was shown on the remains of any of the instruments apart from the barometric altimeter setting. The lower panel switches and circuit breakers had been damaged during the impact. The pitch trim wheel chain drive had derailed, and its position indicator bar was bent out of shape. The throttle and mixture control linkages had also been displaced.

Both wings were displaced and had a slight rearward bend and the right fuel line at the wing route had ruptured. The leading edges of both wings had been compressed and had buckled along the entire length. The fuselage skin behind and beneath the cockpit area was also buckled. The tailplane and fin were undamaged except for a minor compression of the fin tip caused by the aircraft settling onto its back after the impact.

Flying controls

The ailerons were correctly attached to the wings and were free to move on their hinges. The aileron control cables had come off their guide pulleys at the wing routes caused by the wing displacement. However, there was cable continuity to the flight control yokes, although these and the mechanisms behind them were jammed by the firewall and instrument panel distortion.

The elevators were free to move on their hinges and the control cables were undamaged and correctly routed. There was continuity between the elevator and hand yokes, but they were in a similar jammed condition as the ailerons. The pitch trim tab was set at 8 mm down which give a nose-up trim setting. Its control cables were also correctly routed and were undamaged. The hand wheel chain drive was derailed. The position indicator was bent out of shape and could not be relied upon to be a true indication of the trim tab position.

The rudder was free to move on its mountings and its cables were correctly routed and connected to the rudder pedals. Despite the damage to the firewall and distortion to the rudder pedals, they were able to provide a small amount of rudder movement.

The right wing flap was locked in position by its electrically driven screw jack and was 80 mm down. The left flap was loose in its tracks because the synchronising cables had come out of their pulleys as a result of the wing displacement during the impact. The inner ribs of both flaps and associated skin were distorted.

Stall warner

The stall warner orifice in the left leading edge contained soil residue. Distortion of the wing leading edge during the impact had caused a crack in the plastic cup at its tube attachment point. However, when a vacuum was applied directly to the tube the warning horn sounded correctly.

Engine

The engine had been pushed backwards into the firewall by the impact trapping and distorting the ancillary components in the process. The engine tubular mounting frame was misshapen and some of its welded joints had cracked. A large amount of soil and debris was found within the engine cowl and around the front cylinder cooling fins. The propeller was bent and misshapen and showed the engine to have been at a high power setting at the point of impact. An examination of the spark plugs indicated the engine was in a good overall state of tune.

Wheels and brakes

The main wheels and brakes were examined at the accident site and a further detailed examination was carried out at the AAIB. The wheel hubs, tyres and brake friction pads were covered in a layer of liquified mud. Prior to recovering the aircraft, the layer of mud was sticky and wet, but it had dried out by the time it arrived at the AAIB.

The inside of the wheel fairings was also covered in mud in the same way. At the accident site the left wheel, although stiff, could be rotated by hand whereas the right wheel was seized and could not be rotated. It was eventually freed with the application of a small amount of lubricant on the disc surfaces. Both tyres were found to be correctly inflated and the treads were well defined. The brake callipers and pads were also covered in a layer of liquified mud but underneath were generally in a good, unworn condition. Despite the mud contamination the pistons had not seized in their callipers. However, mud had been smeared onto the disc friction surfaces during wheel rotation and had accumulated on the leading face of the pad friction material.

Crashworthiness

The cabin and cockpit area had retained their basic shape and the left and right seat were correctly attached to the cockpit floor. The left and right four-point harness straps were undone and hanging loosely. The first responders had extracted the pilot, to render first aid, by undoing the harness rotary release wheel. An examination of the straps found them to be in good condition. There was no evidence of overloading on the floor mounting plates of the lap straps or the cables, shackles and brackets of the shoulder straps.

The control yoke, windscreen fragments, windscreen frame and cockpit instrument panel coaming showed evidence of impact damage and distortion caused by the pilot as the aircraft hit the ground. This is known as a 'secondary collision', whereby an unrestrained or partially restrained occupant of an aircraft, hits interior fittings and equipment during an accident sequence. It is caused by the inertial mass of limbs, torso and head moving uncontrollably, known as flailing, in this case forward, during a sudden and rapid deceleration, and it results in contact injuries. Using measurements of the distortion, 0.45 m to 0.75 m to the front of the aircraft, and an impact speed derived from the video, the rate of deceleration of the aircraft was calculated[7] to be between 3 and 4.25 g. This rate of deceleration was acting on a partially restrained body. The forces of an unrestrained upper torso and head striking the aircraft structure will be much higher as the deceleration of a head hitting a non-deforming object will result in a substantially higher g-loads.

Testing and research[8] has been carried out into crash survivability in aircraft and vehicle accidents and has found that:

> *'Prevention of the secondary collision is essential to crash survival since relatively minor crashes can result in fatal impacts with interior vehicle structures. There are many different types of belt restraint systems available today, but they mainly involve either pelvic restraint (lap belt) or upper torso restraint (shoulder belt) or a combination of both (3-point, 4-point, and 5-point systems). Lap belt only configurations (2-point restraints) permit tremendous flail of the upper torso in crashes.'*

Medical information

A post-mortem examination was conducted by a consultant pathologist, which revealed that the accident pilot died as a result of head and chest injuries with the pathologist commenting that he expected them to have proved to be "rapidly fatal".

Footnote

7 The figures used to derive the force assume a constant and uniform deceleration and therefore give a conservative figure. It is probable that the initial g force may have been higher but over a very short period of time.

8 Shanahan, Dennis F. M.D., M.P.H. Human Tolerance and Crash Survivability, NATO, 2004.

There was no evidence found from the post-mortem examination findings, or a review of the accident pilot's medical records, of a medical condition likely to cause sudden medical impairment or incapacity.

Injuries

The accident pilot sustained extensive head injuries consistent with the head striking part of the aircraft. He also had witness marks to his right groin and right hip towards his navel and on his left hip towards his navel, which were generally symmetrical. These were likely to be harness marks from the lap straps. There were no fractures to his clavicular (collar bones) which may have been expected as a result of the shoulder harness being worn.

There were marks on his right anterior chest (including sharp edge marks) which may correlate to harness or aircraft parts. There were multiple anterior rib fractures, but these were probably due to chest compressions during cardiopulmonary resuscitation. There were also some posterior rib fractures which are likely to be as a result of contact with part of the aircraft.

Toxicological Findings

Toxicology results were positive for the presence of cocaine metabolites (benzoylecgonine) in the pilot's blood. They were positive for the presence of cocaine and cocaine metabolites (benzoylecgonine) in the pilot's urine. They were negative for alcohol.

The consultant clinical scientist and forensic toxicologist stated that the presence of a low level of benzoylecgonine in the blood, and both cocaine and benzoylecgonine in the urine, indicated it was likely that cocaine had been used within one or two days before the accident. The fact that it was only the inactive metabolite benzoylecgonine that had been found in the pilot's blood suggested that the behaviour of the pilot would not have been directly affected by cocaine on the day of the accident.

The level of carboxyhaemoglobin[9] (COHb) in the pilot's blood was 8.5%, with levels below 10% being regarded as normal.

The medical evidence was reviewed by a consultant interventional cardiologist. His report stated that, in summary, there was no medical evidence that the pilot suffered any acute medical emergency at the time of the accident. Equally there was no significant evidence that he did not. Also, there was no evidence that he was incapacitated due to the ingestion of any drug or other substance. There was also no evidence that he was feeling unwell or complaining of any particular symptoms prior to the accident flight.

Footnote

9 COHb is a stable complex of carbon monoxide (CO) and haemoglobin that forms in red blood cells when carbon monoxide is inhaled. COHb should be measured if CO poisoning is suspected.

CAA Safety Sense Leaflets

Leaflet No 7: Aeroplane Performance[10]

Leaflet No 7 includes the following information:

*'6 **TAKE-OFF - POINTS TO NOTE***

*d) **Use of available length:** make use of the full length of the runway; there is no point in turning a good length runway into a short one by doing an 'intersection' take-off...*

8 SAFETY FACTORS

*a) **Take-off***

It is strongly recommended that the appropriate Public Transport factor,…, should be applied for all flights. For take-off this factor is x1.33 and applies to all single-engined aeroplanes…

*Where several factors are relevant, they must be **multiplied**. The resulting Take-Off Distance Required to a height of 50 feet (TODR) can become surprisingly high.*

*You should always ensure that, after applying all the relevant factors, including the safety factor, the TODR does not exceed the Take-Off Run Available (TORA). If it does, you **must** offload passengers, fuel or baggage.'*

Figures 9 and 10 illustrate these points.

Leaflet No 12: Strip Flying[11]

Leaflet No 12 includes the following information:

*'3 **OPERATING CONSIDERATIONS***

*a) Aeroplane performance **must** be appropriate for the proposed strip. You must be fully familiar with the contents of SafetySense Leaflet No. 7 (Aeroplane Performance)…*

*5 **FLYING CONSIDERATIONS***

i) Always start your take-off run as close as possible to the beginning of the strip, unless there are very good reasons not to do so…'

Footnote

[10] Available: http://publicapps.caa.co.uk/modalapplication.aspx?catid=1&pagetype=65&appid=11&mode=detail&id=1913 (accessed 30 June 2021).

[11] Available: http://publicapps.caa.co.uk/modalapplication.aspx?catid=1&pagetype=65&appid=11&mode=detail&id=1166 (accessed 30 June 2021).

10 SUMMARY:

FACTORS MUST BE MULTIPLIED e.g. 1.20 x 1.35

	TAKE-OFF		LANDING	
CONDITION	INCREASE IN TAKE-OFF DISTANCE TO HEIGHT 50 FEET	FACTOR	INCREASE IN LANDING DISTANCE FROM 50 FEET	FACTOR
A 10% increase in aeroplane weight, e.g. another passenger	20%	1.20	10%	1.10
An increase of 1,000 ft in aerodrome elevation	10%	1.10	5%	1.05
An increase of 10°C in ambient temperature	10%	1.10	5%	1.05
Dry grass* - Up to 20 cm (8 in) (on firm soil)	20%	1.20	15%⁺	1.15
Wet grass* - Up to 20 cm (8 in) (on firm soil)	30%	1.3	35%⁺ Very short grass may be slippery, distances may increase by up to 60%	1.35
Wet paved surface	-	-	15%	1.15
A 2% slope*	Uphill 10%	1.10	Downhill 10%	1.10
A tailwind component of 10% of lift-off speed	20%	1.20	20%	1.20
Soft ground or snow*	25% or more	1.25 +	25%⁺ or more	1.25 +
NOW USE ADDITIONAL SAFETY FACTORS (if data is unfactored)		**1.33**		**1.43**

Notes:
1. * Effect on Ground Run/Roll will be greater. Do not attempt to use the factors to reduce the distances required in the case of downslope on take-off or upslope on landing.
2. ⁺ For a few types of aeroplane (e.g. those without brakes) grass surfaces may decrease the landing roll. However, to be on the safe side, assume the INCREASE shown until you are thoroughly conversant with the aeroplane type.
3. Any deviation from normal operating techniques is likely to result in an increased distance.

If the distance required exceeds the distance available, changes will HAVE to be made.

Figure 9

Table of factors to be multiplied to the flight manual TODR from SafetySense Leaflet 7

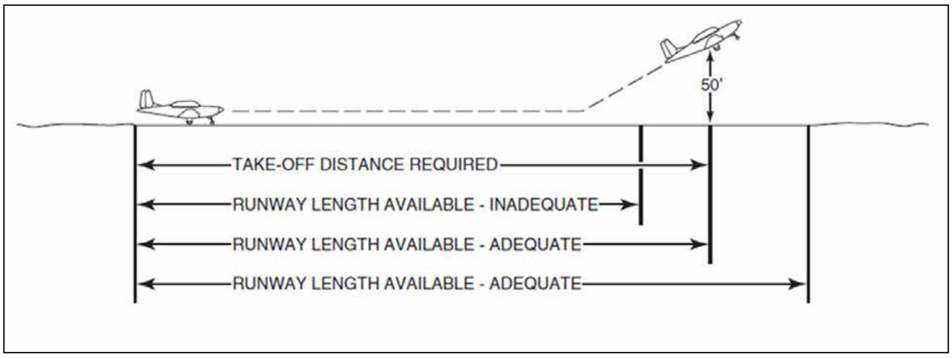


Figure 10

Depiction of TODR and runway length available

Aircraft performance

The AAIB made the following performance calculations for:

Gamston

The TORA of 1,199 m was in excess of the Takeoff Distance Required (TODR) for a C150 in still air.

Netherthorpe Runway 36

The Landing Distance Required (LDR) on Runway 36 at Netherthorpe, using the relevant factors in Figure 9, with an 8 kt headwind, without the additional safety factor (ASF), was 301 m. With the ASF (+43%), it was 430 m. This compares to an LDA of 308 m.

The TODR at Netherthorpe, using the factors in Figure 9, with an 8 kt headwind, without the ASF, was 302 m. With the ASF (+33%) it was 402 m. This compares to a TORA of 361 m.

Troutbeck Runway 36

The LDR on Runway 36 at Troutbeck, using the factors in Figure 9, with a 10 kt headwind, without the ASF, was 420 m. With ASF (+43%) it was 600 m. This compares to an LDA of 450 m.

The TODR at Troutbeck, from the beginning of Runway 36, using the factors in Figure 9, with a 10 kt headwind, without the ASF, was 439 m. With the ASF (+33%) it was 584 m. This compares to a TORA of 450 m.

The TODR from the intersection of Runway 04, using the factors in Figure 9, with a 10 kt headwind, without the ASF, was 428 m. With the ASF (+33%) it was 570 m. This compares to a TORA of 320 m.

The TODR at Troutbeck from the beginning of Runway 36, on a standard atmosphere day, using the dry grass and 0.5% gradient factors in Figure 9, with a 9 kt headwind, with the ASF, was 449 m.

These figures are summarised in Table 2 (with colour-coding to separate takeoff from landing data for each runway).

Distances in m	Gamston Runway 03	Netherthorpe Runway 36	Troutbeck Runway 36 full length	Troutbeck Runway 36 from intersection
TORA	1,199	361	450	320
TODR (No ASF)	<TORA	302	439	428
TODR (With ASF)	<TORA	402	584	570
LDA	N/A	308	450	N/A
LDR (No ASF)	N/A	301	420	N/A
LDR (With ASF)	N/A	430	600	N/A

Table 2

Summary of takeoff and landing performance figures

Test and research

C150 handling characteristics – test profiles

As part of the investigation, a flight trial was carried out in another C150 to assess the likely handling qualities and performance of G-CIIR, with various trim settings and FLAP 10 selected. The flight was conducted at a similar takeoff weight and CG to G-CIIR[12] by a qualified test pilot, using standard EASA CS-23[13] test techniques. The assessment specifically looked at the following:

1. *Normal takeoff with elevator trim set for takeoff* – to establish the control column and rudder forces during a normal takeoff.

2. *Short field landing* - to establish the deflection of the elevator trim tab after a short field landing with FLAP 40.

3. *Takeoff with elevator trim tab at 8 mm of nose-up deflection* – to establish the control column forces with the elevator trim tab set as found on the accident aircraft.

4. *Full power stalls* – to establish the stall characteristics with FLAP 10 and FULL power applied.

Footnote

[12] The takeoff weight of the test aircraft was 1,490 lb (estimate for G-CIIR was 1,479.62 lb) and the CG was 867 mm aft (estimate for G-CIIR was 847 mm inches aft). The CG position of the test aircraft would have resulted in a negligible reduction in longitudinal stability over that of G-CIIR.

[13] CS-23 is the EASA certification specification for normal, utility, aerobatic, and commuter category aeroplanes.

C150 handling characteristics – test results

The results of the flight tests were as follows:

1. *Normal takeoff with elevator trim set for takeoff*

A normal takeoff with FLAP 10 was flown. Initially the aircraft ran straight but as the speed increased a very "modest" right pedal input (about 1 to 2 cm) was required to keep the aircraft straight. A gentle aft pressure on the control column allowed the nosewheel to be lifted off by 40 KIAS with the aircraft flying off at 50 KIAS. The takeoff trim setting equated to an attitude of about 12° nose-up, which gave 55 to 60 KIAS "hands-off" with full power applied. Maintaining 55 KIAS required moderate attention and resulted in a high nose-up attitude with degraded field of view.

2. *Short field landing*

The aircraft was flown for a short field approach and landing with FLAP 40 selected, with a small amount of power applied, to give a normal approach angle. The elevator trim required equated to that found on the accident aircraft.

3. *Takeoff with elevator trim tab at 8 mm of nose-up deflection*

A normal takeoff was conducted. The aircraft flew off at 50 KIAS and the speed was maintained at 55 KIAS. With the elevator trim set to that found on the accident aircraft a "very modest push force" of 4 daN (4 kgf) was required to hold the speed.

4. *Full power stalls*

The aircraft's stalling characteristics were assessed at full power, with FLAP 10 and the elevator trim selected to that found on the accident aircraft. As the aircraft slowed it adopted a high nose-up attitude with degraded field of view. With the aircraft kept in balance, by applying a modest right rudder input, the aircraft slowed below 40 KIAS and the stall warner sounding with the stall occurring at about 30 KIAS. The stall was generally defined by a "g break" or nose-down pitch change.

With no rudder applied, the aircraft yawed left and then rolled left. With no rudder this eventually led to the aircraft's nose dropping in the turn before a full stall was achieved. However, with a modest right rudder input the stall would be achieved with a left wing drop.

Overall, the full power stall characteristics were relatively benign, but the high noseup attitude would make it difficult for an inexperienced pilot to ascertain the aircraft's attitude, and the yaw/roll might go un-noticed.

Analysis

The aircraft

Examination of the aircraft found no evidence of a structural failure that could have led to this accident. There was also no evidence to suggest any malfunction of the flying controls, and physical and audio evidence showed the engine was producing power until the impact.

The light grey coloured dust-like cloud observed a few metres behind the aircraft before it got airborne was not considered to have come from the aircraft but had most likely been displaced limestone dust from the runway soakaway as the aircraft travelled over it. The stall warner was damaged during the impact. However, despite this, correct operation could be demonstrated under test and therefore there was no reason to doubt that it was able to warn the pilot of the onset of stall during the accident flight.

The first flight to Troutbeck

The accident pilot first visited Troutbeck on 25 May 2020 while still a student pilot. This was authorised by his supervising instructor who assumed he had obtained PPR, which he had not. Had he attempted to obtain PPR, the airfield owner would not have granted it, given his lack of experience and a licence.

Flight planning

The accident pilot was recently qualified with only two hours of flying since passing his LST. As discussed with his instructor, the plan to go to Troutbeck was beyond his experience, but having had an uneventful previous visit it may have given him the confidence to return, albeit in different conditions.

The accident pilot did not request PPR for Netherthorpe or Troutbeck despite both airfields requiring it. When the accident pilot messaged the M7 pilot about calling Troutbeck before departing, he was told: "CALL PROBABLY GOOD BUT NOT ESSENTIAL". However, the airfield's plates clearly state 'Strictly PPR'. Had they prepared more thoroughly they would have known to request permission in advance. Had the accident pilot tried to obtain PPR it would have been refused and the accident could have been avoided.

Similarly, the M7 pilot stated he used the microlight frequency 129.825 MHz for the approach and believed the accident pilot did the same. Assuming that the accident pilot was not on the SafetyCom frequency, as stated on the airfield's plate, he would not have been able to receive the airfield owner's transmissions. Had he heard them, he would have been refused permission to land and the accident would not have happened.

It was calculated that the LDR for the flights into Netherthorpe and Troutbeck, with the ASF applied, were in excess of the LDA.

It was calculated that the TODR for the flight out of Netherthorpe, with the ASF added, was greater than the TORA. It was also calculated that the TODRs for the accident flight, from the start of Runway 36 and from the intersection with Runway 04, with the ASF added, were in excess of the TORA.

It was also calculated that the aircraft took off from Gamston and Netherthorpe and landed at Netherthorpe and Troutbeck above the aircraft's maximum authorised weight. A limitation is imposed on the maximum authorised weight at which any aircraft is permitted to operate. This limitation depends on the strength of the structural components of the aircraft and the operational requirements it is designed to meet. If these limitations are exceeded, the safety of the aircraft may be jeopardized and its operational efficiency impaired.

All these findings suggest that the accident pilot had either forgotten to calculate the performance and weight and balance figures, or considered he could operate into Troutbeck again without doing the necessary planning, perhaps because he had visited before without event, albeit in better conditions and without a passenger.

The accident flight

The M7 pilot stated that he believed the accident pilot did not have time to perform his engine power checks and pre-take off checks in the time it took him to taxi out to the runway and takeoff. While it is not known if he used the checklist, given it was found at the '*AFTER START TAXYING and POWER*' page with mud and scrape marks, and the 'PRE-TAKE OFF CHECKS – VITAL ACTIONS' were on the following page, it is probable that they were not completed. This may have been because the pilot did not want to get his aircraft stuck in the mud, as had happened after he initially tried to start taxiing. This may also be the reason why he started the takeoff run from the intersection rather than backtracking to the beginning of the runway, as instructed to do by the airfield owner, or to a point halfway between the intersection and runway threshold, as he had told the M7 pilot he would do. In either case, not using the full length of the runway for a performance-limited takeoff was contrary to the guidance in Safety Sense Leaflets 7 and 12.

The M7 pilot did not believe the accident pilot's shoulder harness was secure when he released his harness prior to removing him from the aircraft. Given that the pilot had a previous tendency to not wear his shoulder harness, he taxied out and took off hastily, and his head and chest injuries indicated probable contact with parts of the aircraft, it was concluded that the shoulder harnesses were probably not secured prior to take off.

The video evidence indicated that after taking off the aircraft had some left yaw with a brief left roll component. The condition of the runway was described as sludgy and the aircraft was found with lots of mud on its underside. Additionally, the left mainwheel was free to rotate whilst the right mainwheel brake appeared to be binding. This was probably a result of the mud that was discovered on its brakes friction surfaces. With this binding brake, the right wheel would have had higher rolling resistance compared to the left, leading to a tendency for the aircraft to drift right during the takeoff. This would have required the pilot to apply left rudder on the takeoff roll to maintain the aircraft's track along the runway centre line. If the pilot maintained left rudder after the aircraft became airborne, it would have caused the left yaw and initial left roll as observed in the video.

With the aircraft heading towards the conifer plantation, the pilot would have found himself in an uncomfortable situation, and one he was unlikely to have experienced before. The increase in the aircraft's pitch attitude was consistent with him attempting to climb above the plantation, although it might also have been related to the elevator trim being set for landing, not takeoff (see *Flight characteristics*). It is likely that the high nose attitude caused the airspeed to decrease triggering the stall warner and leading to the left wing dropping as it stalled, with the aircraft then entering the near vertical dive. With any yaw applied the tendency for the aircraft to depart controlled flight was increased.

Any inability to recognise the yaw to the left and to react appropriately to the stall warner (which probably sounded) is likely to be linked to the pilot's lack of experience.

Having departed controlled flight and entered the dive at about 50 ft agl, there was insufficient height available in which to execute a recovery.

Flight characteristics

The flight trial found that the pilot probably took off with the elevator trimmer at the same position it was after he had landed. With it not reset to the takeoff position, the aircraft would have required a push of 4 DaN on the control column to hold the takeoff attitude. While this is a moderate force and controllable, had the pilot become distracted and relaxed his hold on the control column, or suffered some form of incapacitation, the aircraft would have pitched up. This would have caused the aircraft's speed to decrease, which, if not corrected in a timely manner, would lead to the aircraft stalling and departing controlled flight. Any yaw applied at or close to the stalling speed of the aircraft – as appeared likely in this accident – would hasten any tendency for the aircraft to depart controlled flight.

The fact that the trimmer was probably not set for takeoff also suggests that the pre-takeoff checks were not completed.

No single handling or performance characteristic of the aircraft was identified that would be difficult to control. However, it was still possible for the aircraft to adopt an uncomfortable and unusual attitude that, if uncorrected, would lead to the stall and associated wing drop.

Conduct of the flights

The flights after the pilot passed his LST and which led up to the accident flight were characterised by incomplete preparation and an apparent disregard of advice from those notably more experienced than him. It is possible that his previous visit to Troutbeck, authorised by one of his instructors, may have given him the confidence to return there. However, it appears that the chastisement and subsequent discussion with one of his instructors at the M7 pilot's airstrip, about what type of flying was appropriate for a newly qualified pilot, was not heeded. During the takeoff from Troutbeck – an airfield on the limits of the aircraft's performance capabilities – the pilot rushed; he did not use the full length of the runway; it is likely he used a nose-up elevator trim setting appropriate to landing having not completed his pre-takeoff checks; and it is likely he did not fasten his shoulder harness.

The toxicologist stated that the pilot's behaviour would not have been directly affected on the day of the accident by the aftereffects of his previous cocaine use.

The consultant interventional cardiologist stated that there was no medical evidence that the pilot suffered any acute medical emergency that may have caused some form of incapacitation. Equally there was no significant evidence that he did not. Immediately after takeoff, the aircraft yawed and rolled to the left but the wings were then levelled. This would have required control input from the pilot, suggesting that he was not incapacitated at that point. Nevertheless, the possibility that the pilot became incapacitated in the final seconds of the flight could not be excluded.

It was considered likely that his conduct during the flights leading up to and including the accident are explained by an apparent willingness to trust his own judgement over the advice of others.

Survivability

The aircraft descended vertically into waterlogged but dense soil. The engine was at a high power setting and the rotating propeller cut itself into the soil lifting out a large divot in the process. At the same time, the engine frame and nose section became compressed until both wing edges contacted the ground, as shown by the marks in the soil. The aircraft appears have been brought to a stop in a distance estimated to be between 0.45 m to 0.75 m, based on the impact hole and shortening of the nose section. Using an impact speed derived from the video evidence, the aircraft and pilot sustained an impact deceleration between 3 g and 4.25 g. These forces are not particularly high and should have been survivable.

The pilot received fatal injuries to his head and chest and there was no evidence of a medical condition likely to cause sudden medical impairment or incapacity. Given that some of his injuries were probably sustained by contacting the aircraft and it is likely he was not wearing his shoulder harness, these injuries may have been less severe and possibly survivable had the shoulder harness been worn.

Conclusion

The aircraft had a valid ARC and was in a good overall condition. There was no evidence of any system malfunction or structural failure that could have been causal or contributed to this accident. All the damage to the aircraft was consistent with a frontal impact with waterlogged but dense soil.

The accident was caused when a high nose attitude immediately after takeoff caused the airspeed to reduce to such an extent that the aircraft stalled with a wing-drop to the left. The high nose attitude was made more likely by the fact that the elevator trim remained set for landing, probably because the pilot did not carry out his pre-takeoff checks as he rushed to depart while not becoming stuck in the muddy surface. The wing-drop was consistent with residual left yaw at the stall, a condition considered likely because of the left roll and yaw observed immediately after takeoff. The left yaw was probably a result of the pilot not reducing the left rudder input that would have been required during the ground roll to overcome the effect of the right brake binding while rolling over the muddy runway surface.

Pilot incapacitation in the final seconds of the flight could not be ruled out but was considered unlikely.

Opportunities were missed to prevent the accident because the pilot did not heed the advice not to operate into grass, performance-limiting airfields, did not obtain PPR and was probably not on the correct radio frequency on arrival. It is likely that the pilot did not fasten his shoulder harness, against the strong advice of his instructor, and this action may have meant the accident became unsurvivable.

Flying for any pilot is a continual learning process whether they are newly qualified or very experienced. However, newly qualified pilots should be very careful to make sure they fly within the limits of their experience. This accident highlights the fact that thorough preparation is essential for every flight, and accidents can happen if short cuts are taken or good advice is not heeded.

Published: 18 November 2021.

AAIB Correspondence Reports

These are reports on accidents and incidents which were not subject to a Field Investigation.

They are wholly, or largely, based on information provided by the aircraft commander in an Aircraft Accident Report Form (AARF) and in some cases additional information from other sources.

The accuracy of the information provided cannot be assured.

SERIOUS INCIDENT

Aircraft Type and Registration:	Boeing 777-336ER, G-STBA
No & Type of Engines:	2 General Electric Co GE90-115B turbofan engines
Year of Manufacture:	2010 (Serial no: 40542)
Date & Time (UTC):	2 July 2021 at 0945 hrs
Location:	London Heathrow Airport
Type of Flight:	Commercial Air Transport (Cargo)
Persons on Board:	Crew - 16 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	53 years
Commander's Flying Experience:	17,000 hours (of which 10,300 were on type) Last 90 days - 91 hours Last 28 days - 24 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

A FIRE CARGO AFT warning illuminated during the pre-start procedures. The crew were advised by RFFS to conduct a rapid disembarkation via an airbridge. One cabin crew member suffered minor injuries during the disembarkation.

The fire warning was triggered when a short circuit in the battery pack of a refrigerated container in the aft cargo hold caused heating of cables and smoke. Safety action was taken by the operator and container manufacturer to reduce the probability that damage to a container would lead to such an event again.

History of the flight

During the pre-start procedures a FIRE CARGO AFT warning illuminated, and the fire bell audio warning sounded. The crew actioned the FIRE CARGO AFT checklist from the Quick Reference Handbook (QRH). If the aircraft is on the ground with cargo doors open the FIRE CARGO AFT checklist states that the checklist should only be accomplished if there is an actual fire. Therefore, the additional co-pilot on the crew was asked to go to the cabin and investigate. He initially went to the rear of the aircraft cabin and looked out from the windows to the area of the rear cargo door. He could see that the door was open but at this point there were no signs of fire or any fumes in the cabin. He returned to the flight deck and reported these findings to the commander.

The additional co-pilot then went outside the aircraft to liaise with the loading crew and to ascertain if there was an actual fire. Due to the long airbridge jetty there was a significant elapsed time before the co-pilot reached the ground. On board, the cabin crew reported to the commander that there were acrid fumes in the passenger cabin. The commander decided to pause the FIRE CARGO AFT checklist to instead commence the SMOKE, FIRE AND FUMES checklist. Shortly after the FIRE CARGO AFT occurred, the indications cleared indicating that the relevant condition was no longer being sensed.

A public address (PA) broadcast was made to alert the cabin crew and a PAN call was made by RTF to alert ATC and to request fire service assistance. The PA to the crew was an *'Attention Crew! At Stations'* call which is intended to prepare the cabin crew to respond to an emergency situation. It requires all cabin crew members to go to their allocated seating positions adjacent to exit doors. So, in response to the call some of the crew were positioned toward the rear of the aircraft in the area of the fumes.

As the additional co-pilot approached the rear cargo hold, he saw two of the loading team running clear of the aircraft. They reported to him that there were acrid fumes in the rear cargo hold. Immediately after this conversation, the RFFS arrived and the co-pilot had a brief discussion about the situation with the RFFS commander. The RFFS commander then told the co-pilot that he wished the aircraft to be cleared of personnel.

The additional co-pilot returned to the aircraft to pass on the direction for a precautionary disembarkation of the aircraft via the air bridge which was connected to the left No 2 passenger door. After informing the commander, the additional co-pilot was directed to inform the cabin crew. The APU was shut down and the aircraft secure checklist was completed, and the crew left the aircraft via the airbridge. During the disembarkation one of the cabin crew tripped on a cargo net which was being used to secure cargo in the passenger cabin. The total time from the fire warning sounding to all crew being off the aircraft was approximately 8 minutes.

Organisational information

The use of the *'Attention Crew! At Stations'* Call is described in Part B of the Operator's Operations Manual (OMB). The relevant section is shown in Figure 1.

The OMB gives the information at Figure 2 for the use of a rapid disembarkation PA. The commander was aware of this PA but considered its wording to be inappropriate for the situation.

ALL

3.2.1 Hazard Call

On the ground, if a potentially hazardous event occurs that requires all cabin crew to have an increased level of alertness, the Commander shall make the announcement:

"ATTENTION CREW! AT STATIONS!"

This announcement should be made as soon as the aircraft has come to a stop with the parking brake set. It should be prioritised alongside any initial technical actions required by QRH and/or electronic checklists. The announcement can be used on the ground from when the aircraft doors are closed for departure until the aircraft doors are opened for disembarkation.

The 'increased level of alertness' is in addition to the Cabin Crew Safety Focus Period ("SEATS") that cabin crew must observe during each take-off and landing safety focus period, as specified in *OM B General Procedures 1.5.2 Cabin Crew Safety Focus Periods*.

Figure 1

Use of 'Attention Crew At Stations'

ALL

3.5.8 Rapid Disembarkation

If a situation develops which warrants a rapid disembarkation but not an evacuation via the slides and a suitable means of exit exists, (e.g. jetty or steps) the following will apply:

The commander will:

- Call the SCCM to the Flight Deck using the standard alert signal; and
- Give NITS brief;
- Make an announcement to the crew and passengers, using the PA.

"ATTENTION, ATTENTION, THIS IS AN IMPORTANT ANNOUNCEMENT. ALL PASSENGERS MUST LEAVE THE AIRCRAFT VIA NEAREST BOARDING DOOR IN A QUICK AND ORDERLY MANNER. LEAVE ALL PERSONAL ITEMS BEHIND".

Note: The SCCM may make this announcement if flight crew are not present.

The SCCM will:

- Report to the Flight Deck for NITS briefing;
- Assist with passenger disembarkation;
- When cabin clear, will liaise with the Commander and brief cabin crew.

The cabin crew will:

Following the announcement made by the Commander or SCCM:

- Stop passenger boarding.
- Encourage passengers to leave quickly through nearest available boarding door and leave personal items behind.
- Check cabin and toilets clear.
- Assemble at boarding door and await instructions.

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Figure 2

Rapid Disembarkation Procedure

Cargo investigation

The rear hold cargo was removed from the aircraft and examined by the RFFS. A refrigerated container was identified as the source of the fumes. The back wall of the container was opened by the RFFS and the container battery pack confirmed as the source. After the RFFS had disconnected the batteries, the container was taken to a warehouse at Heathrow and then subsequently returned to the manufacturer for further examination.

The manufacturer's investigation report stated that:

> *'the smoke was a consequence of improper handling of the container, which led to a short circuit of two of the batteries. The short circuit was caused by a significant impact/collision on the back of the container, where the affected batteries are located.'*

Photographs of the damage are at Figure 3.

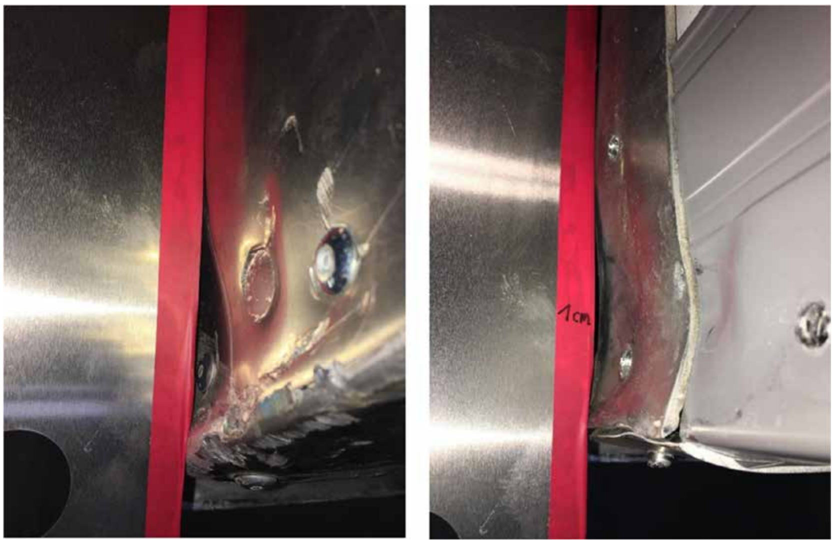

Figure 3
Impact damage to container

In the opinion of the manufacturer the damage was the result of a significant impact to the container, beyond what should be expected in routine handling. The deformation caused a bracket in the battery compartment to be torn from its mounting. The manufacturer made the following finding:

> *'As one of the brackets to secure the batteries had been compromised, the batteries were able to shift sideways which led to the battery cables/poles rubbing against a secondary securing bracket. As a result, the battery cables sheared and heated which led to a short circuit as expected. This prevented any further incident to the container electrics that would lead to a fire outbreak. The heating of the cables caused the smoke which highlighted the incident to the ground handler.'*

The manufacturer described the cables as "short circuit proof" and gave the following information:

> *'The safety systems designed to prevent a fire have worked correctly. The observed smoke is due to the heated battery cables which were a result of the short circuit. These short-circuit-proof cables are designed to perform in such a way that in the event of a short circuit, smoke is produced, but no fire. This prevents any further damage to other parts of other container, the area surrounding the container and the aircraft too. The short-circuit-proof cables functioned as expected in instance.'*

Data recorded by the container indicated it had last been charged between 0755 and 0839 hrs on 2 July 2021. At that time no abnormalities were recorded and there were no reports of smoke being observed. The manufacturer believed, therefore, there was no short circuit at that point.

Analysis

The FIRE CARGO AFT warning QRH checklist directs that, with the cargo door open, the aircraft's cargo fire extinguishers should only be discharged if the presence of a fire can be confirmed. The commander sent the extra pilot on the crew to investigate the situation while he and the co-pilot actioned the QRH and communicated the issue to ATC. On hearing reports of fumes in the cabin, the commander decided to action the QRH checklist for SMOKE, FIRE AND FUMES. In common with the FIRE CARGO AFT checklist the actions are principally intended for situations where the aircraft is in flight. The QRH did not therefore present any step-by-step path of action to the crew. The fact that the warning cleared shortly after its appearance indicated to the commander that the situation may not be serious, and he was conscious of gathering evidence to clarify decision making and avoid precipitate action.

The *'Attention Crew! At Stations'* PA is intended for use after doors close and directs all of the cabin crew to take their allocated positions next to aircraft exit doors. Some crew members were therefore redeployed from the forward to the aft cabin, into the vicinity of the aft cargo hold. In retrospect, the commander considered that a PA telling the cabin crew to prepare for a rapid disembarkation would have been more appropriate.

The operator does have a standard PA for rapid disembarkation via boarding doors rather than evacuation slides. However, the wording of that is very much directed at a situation with passengers on board. In this case, with only cabin crew aboard, the commander felt that the standard wording may have only added confusion rather than giving clear direction to the crew.

When the additional co-pilot informed the commander of the advice from the RFFS, the commander then directed him to return to the cabin and tell the cabin crew to leave the aircraft.

The examination of the container indicated that it been subject to a collision which caused damage to a battery bracket. The damage allowed the batteries to move position and cause a short circuit. The electrical system had been designed to tolerate this damage, though the subsequent heating of the battery cables produced the smoke that triggered the FIRE CARGO AFT warning.

Conclusion

A short circuit in the battery pack of a refrigerated container loaded in the aircraft aft cargo hold caused heating of cables in the pack and, therefore, smoke to be produced. The smoke was detected by the aircraft fire detection systems and a FIRE CARGO AFT warning was triggered. The crew disembarked through the boarding door.

Safety Action

Following this event, the following Safety Action was taken:

> The container manufacturer decided to consider reinforcing the battery attachment and, if necessary, make modifications to improve the functionality and safety of the container.
>
> The operator decided to consider introducing a comprehensive damage check on all similar containers before they are loaded onto aircraft.

ACCIDENT

Aircraft Type and Registration:	Grob G102 Astir CS, G-CJSK
No & Type of Engines:	None
Year of Manufacture:	1977 (Serial no: 1521)
Date & Time (UTC):	23 June 2021 at 1337 hrs
Location:	Gibett Hill, Brentor, near Tavistock, Devon
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Other
Commander's Age:	65 years
Commander's Flying Experience:	229 hours (of which 69 were on type) Last 90 days - 13 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The right aileron L'Hotellier control connection in the fuselage became disconnected in flight, causing the pilot to abandon the glider by parachute. The control connection was equipped with a secondary Wedekind sleeve locking device, and the pilot had conducted a positive control check to his satisfaction prior to the accident flight. The investigation demonstrated that it is possible to partially assemble this type of control connection such that the connection is not secure, despite appearing to be so during a positive control check. The BGA has provided guidance to affected aircraft owners on how to inspect this type of control connection to ensure that it is secure, following glider assembly.

History of the flight

The glider was assembled by the pilot with two assistants during the morning and the pilot connected the airbrake and aileron control connections in the fuselage. The aileron control surfaces appeared to move normally as the pilot moved the control column, and a positive control check[1] was carried out to his satisfaction.

Footnote

[1] A positive control check is an activity involving two individuals in which one holds a control surface stationary and the other attempts to move the flight control in both directions. The check is intended to verify that each control surface moves correctly when the flight controls are deflected, and for a glider includes the ailerons, flaps (if fitted), rudder, elevator and airbrakes.

The pilot launched by winch from Brentor[a] Airfield at 1250 hrs and climbed to an altitude of 4,100 ft for local soaring. After flying for approximately 50 minutes the pilot heard a metallic noise from behind him and he noticed that the ailerons felt less responsive than normal. He observed that some left aileron input was required to maintain straight and level flight, and that the right aileron was not responding to control inputs. The glider was traversing an area of sinking air and as the pilot increased speed to 55 kt the wings began to flutter from the airbrakes out to the wingtip. The pilot reduced airspeed and the flutter stopped.

The pilot flew back towards the airfield whilst assessing the degree of control he had over the glider. He tried some 'S' turns and found it difficult to fly smooth turns, and as the airspeed increased above 55 kt the wings started fluttering again, shaking the whole airframe. He considered that he had insufficient control over the glider's flightpath to safely land and therefore parachuted from the glider at an altitude he estimated to be between 1,500 to 2,000 ft, having ensured that he was over an uninhabited open area.

As the parachute canopy opened the harness was dragged past the pilot's ears causing minor lacerations. The pilot described the parachute landing as heavy, causing minor bruising but no serious injury.

Accident site

The glider came to rest in an area of open ground approximately 1 nm NNE from Brentor[a] Airfield in an inverted attitude (Figure 1).

Figure 1

Accident site

All components of the glider were present at the accident site apart from the canopy, which had been jettisoned in flight and was recovered a short distance from the aircraft wreckage.

Footnote

[a] **Bulletin correction:** this was inadvertently stated as Bodmin when originally published. The online version of the bulletin was corrected on 15 December 2021.

Aircraft examination

Examination of the wreckage revealed that the right aileron control connection in the fuselage was disconnected. The right aileron pushrod was projecting from the fuselage, having penetrated the fuselage skin during the ground impact (Figure 2). The left aileron and airbrake control connections were found to be securely connected.

Figure 2

Disconnected right aileron control pushrod, having penetrated the fuselage during the ground impact

Control connection

The aileron and airbrake control connections in the fuselage were of the L'Hotellier type, in which a ball on the wing pushrod end engages with a socket in the L'Hotellier fitting at the end of the fuselage pushrod (Figure 3). A spring-loaded lock plate is pressed downwards during assembly of the connection, which allows a seat to move away from the socket such that the ball may enter the socket. The ball is locked into the socket when the lock plate moves to its upward position, under spring loading, allowing the seat to contact the ball.

A secondary means of locking the L'Hotellier fitting in the connected position was required following the issue of LBA[2] Airworthiness Directives 1993-001/3[3] and 1994-001/2[4]. One method of compliance was to secure the lock plate with an R-clip through a locking pin hole, drilled though the lock plate, preventing vertical movement when the R-clip was installed.

An alternative method of compliance was the installation of a Wedekind sleeve, which introduced a spring-loaded collar between the end of the pushrod and L'Hotellier fitting (Figure 4). The sleeve pushes away from the L'Hotellier fitting to permit assembly of the control connection, and extends by spring action when released to prevent the L'Hotellier lock plate from moving downwards, providing the secondary locking function. G-CJSK had Wedekind sleeves fitted to the airbrake and aileron control connections within the fuselage.

Footnote

[2] Luftfahrt-Bundesamt, the national civil aviation authority of Germany.
[3] Airworthiness Directive 1993-001/3, L'Hotellier ball and socket connections, 9 April 1998.
[4] Airworthiness Directive 1994-001/2, L'Hotellier ball and socket connections, 9 April 1998.

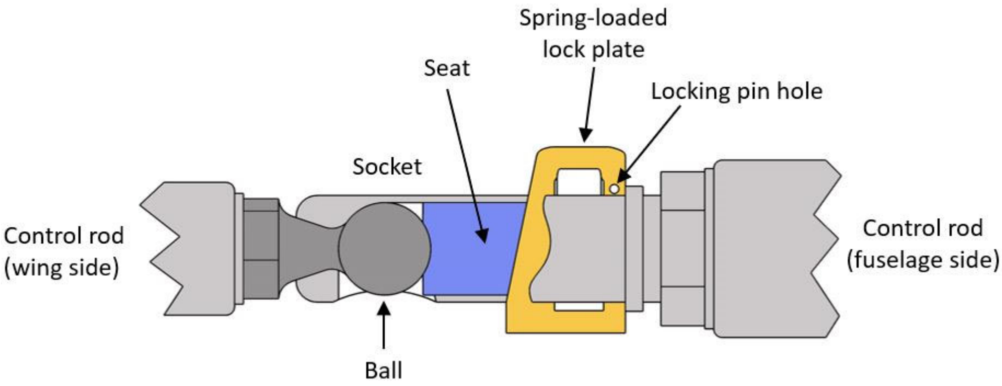

Figure 3
L'Hotellier control connection components

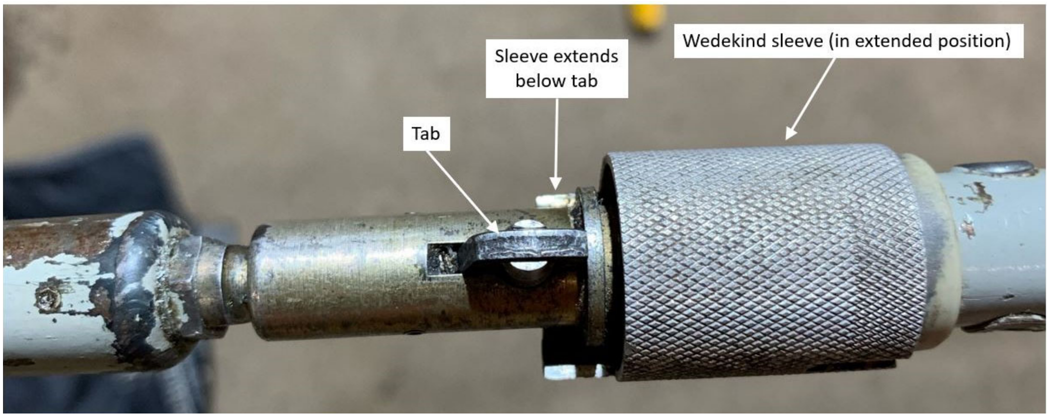

Figure 4
L'Hotellier control connection with Wedekind sleeve correctly fitted
(image courtesy of the BGA)

British Gliding Association investigation findings

The BGA conducted a safety investigation which identified that it was possible to assemble a Wedekind sleeve-equipped control connection in an unsafe manner, with the L'Hotellier ball partially engaged in the socket and with the Wedekind sleeve in contact with the L'Hotellier lock plate, preventing the lock plate from returning to its locked position (Figure 5).

Testing conducted by the BGA showed that with the Wedekind sleeve partially engaged it was possible for a glider to pass a positive control check, due to the partial engagement of the ball in the L'Hotellier socket, but when a small vertical load was applied to the fuselage pushrod the control connection became disconnected.

Analysis

The right aileron L'Hotellier control connection became disconnected after approximately 50 minutes of flight leading to a reduction in the pilot's control over the glider's flightpath and for the disconnected aileron to cause wing flutter when the airspeed increased above 55 kt.

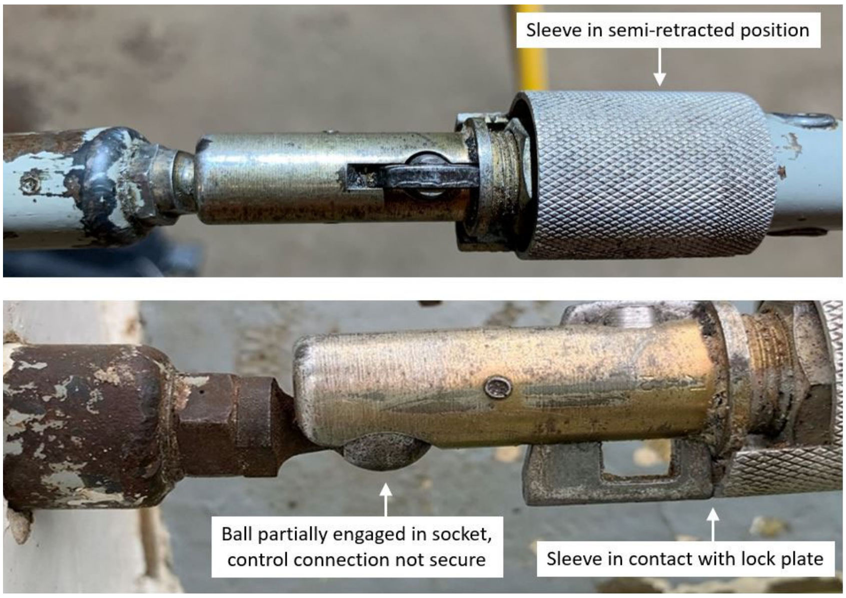

Figure 5

L'Hotellier control connection with the Wedekind sleeve partially engaged, control connection not secure (images courtesy of the BGA)

Since the pilot had assembled the glider on the day of the accident and had completed a positive control check prior to takeoff, it is likely that the right aileron control connection was not securely locked and became disconnected in flight, probably due to turbulence. Testing conducted by the BGA demonstrated how a L'Hotellier control connection with a Wedekind safety sleeve may be assembled in an insecure manner such that a positive control check may not detect the unsafe condition. The location of the aileron and airbrake control connections in the fuselage provided limited access to visually check the security of the control connections once they had been assembled.

Safety action

The BGA has informed all owners of UK-registered sailplanes equipped with L'Hotellier control connections of the findings of its safety investigation. The safety information included guidance on how to physically check that Wedekind sleeves, where installed, are correctly locked by the application of a gentle pulling force on the socket, away from the ball. The BGA also published a video[5] containing similar safety information.

Further safety information relating to the security of sailplane control connections is contained in EASA Safety Information Bulletin 2019-07[6].

Footnote

[5] https://www.youtube.com/watch?v=ydUy2Jx097o, *Understanding how Wedekind connections work* [accessed 2 July 2021].

[6] EASA Safety Information Bulletin 2019-07, *Sailplane Rigging – Procedures, Inspections and Training*, 30 April 2019.

ACCIDENT

Aircraft Type and Registration:	Parrot Anafi USA
No & Type of Engines:	4 electric motors
Year of Manufacture:	2020
Date & Time (UTC):	3 April 2021 at 2337 hrs
Location:	Quarry Span Hill, Henley on Thames, Oxfordshire
Type of Flight:	Commercial Operations (UAS)
Persons on Board:	Crew - None Passengers - None
Injuries:	Crew - N/A Passengers - N/A
Nature of Damage:	None
Commander's Licence:	Other
Commander's Age:	49 years
Commander's Flying Experience:	3 hours (of which 1 was on type) Last 90 days - 1.5 hour Last 28 days - 0.5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further AAIB enquiries

Synopsis

While conducting a flight in support of police search operations, the pilot became concerned about losing visual line of sight with the unmanned aircraft (UA) and attempted to activate the return-to-home (RTH) function. The UA had not acquired a GPS signal prior to the flight and therefore did not record its takeoff point, rendering the RTH function ineffective. The UA lost connection with the controller and drifted in the wind. It was located undamaged the next day approximately 5 km away, having performed an automatic landing.

History of the flight

The Parot Anafi USA[1] was being operated at night above a quarry in a rural area, in support of police search operations. The pilot reported that he completed pre-flight checks and checked the weather forecast before the flight. He reported the actual weather conditions as a light easterly wind, visibility of more than 1 km, scattered cloud and a temperature of 3 to 4 °C.

The pilot reported that following a normal takeoff, he climbed the UA to 40 m above ground level at the edge of the quarry, before gradually positioning it over the quarry in the hover, approximately 120 m away from the takeoff point. He became aware of the presence of

Footnote

1 The Parrot Anafi USA is a small Class C1 UAS with a maximum takeoff weight of 501 grams.

mist in the area where the UA was operating and stated that the blue LED visibility light on the UA was becoming harder to see. As he was uncertain of the orientation of the UA, he activated the RTH function but the aircraft did not fly towards the takeoff point as he expected. He recalled that he pressed RTH once again to cancel the command, but the UA continued to fly in a northerly direction until it was out of sight and the screen of the controller went black.

The UA was found undamaged the next day in a playground approximately 5 km north of the takeoff point.

Personnel

The pilot had completed a five day basic General Visual Line of Sight Certificate (GVC) course with a commercial training organisation in September 2020, accruing 2 hours flight time on a DJI Mavic UAS. He did not fly again until February 2021, when he undertook a 33 minute training flight on the Parrot Anafi USA and assessment with an instructor, during which he was assessed to have demonstrated operational flying competency to a safe standard. He undertook a further two operational flights in February and a self-training flight in March. At the time of the accident, he had approximately 3.5 total flight hours, of which approximately 1.5 were on the Parrot Anafi USA.

Recorded information

The UAS manufacturer provided the following information after analysing the log file from the accident flight. The flight commenced 37 seconds after the UAS was switched on; the battery state of charge was 99 %. The UA did not acquire a GPS signal at any point prior to or during the flight. The UA was flown to approximately 100 m barometric altitude. The RTH function was first selected after three minutes and 53 seconds of flight. It was then selected a further four times. The UA lost connection after five minutes and 53 seconds of flight.

The UAS manufacturer indicated that the smartphone device used to control the Anafi would have received alerts via the Parrot FreeFlight 6 application advising of no GPS signal. The manufacturer indicated that in the absence of GPS, it would expect that the UA is either not flown or flown with extreme caution. As the UA did not acquire a GPS signal, it would not have recorded the takeoff position, rendering the RTH function ineffective. After losing connection, the UA was carried by the wind.

Organisational information

The CAA does not specify a minimum time for UAS pilot currency. In common with other UK police forces, the operator's own currency requirements stipulate a minimum of 2 hours flying within a rolling 90 day period. Its operations manual indicates that this can consist of training or operational flights. If a pilot falls below the currency requirement, a requalification flight assessment is required with the chief pilot/instructor. If a period of inactivity occurs, defined as fewer than two flights in the previous month or no flights in the previous two months, a pilot must undertake a flight assessment with the chief pilot/instructor before operational flying.

Following the accident, the operator proposed a period of re-training and re-assessment for the pilot to include: five hours one-to-one flight training with an instructor; one month of coaching/ shadowing with another competent UA pilot; flight assessment by an independent assessor from another police force; a three month review period; and submission of a 'human factors reflective practice report regarding omissions and learning'.

Discussion

Although, the RTH function did not operate as the pilot expected, the UA was still capable of responding to manual control inputs, although none were recorded after the initial attempt to activate the RTH function. It is not known whether the presence of mist cause the pilot's visual line of sight with the UA to be degraded or lost entirely. However, the pilot subsequently had visual contact with the UA as it drifted to the north and there may have been an opportunity at this point to manually fly the aircraft back to the takeoff point.

Following his initial training in September 2020, the pilot's currency had lapsed and in accordance with the operator's procedures, he undertook a training and assessment flight in February 2021 to re-establish flying currency. He then carried out two further operational flights in February and one self-training flight in March. Having completed only one flight in the month preceding the accident flight, this would meet the operator's definition of a 'period of inactivity', requiring the pilot to undertake a flight assessment with the chief pilot/instructor before further operational flying. It is not clear whether this requirement was monitored at an individual or organisational level.

It is notable that the period of re-training and re-assessment for the pilot proposed by the operator following the accident, is substantially longer and more involved than the operator requires for its pilots to achieve initial competence.

Conclusion

The loss of control and subsequent flyaway occurred when the RTH function did not operate as the pilot expected. The RTH function was rendered ineffective because the flight was commenced prior to the acquisition of a GPS signal.

Safety actions

Following the accident, the operator amended its In-Flight Checklist to include an action to confirm the home point is locked, and if time permits, to check the RTH function. It also intends to fit additional LED lighting to its UAs, to assist in maintaining line of sight at night.

ACCIDENT

Aircraft Type and Registration:	UAVE Prion Mk 3 (UAS, registration n/a)
No & Type of Engines:	1 Valach piston engine
Year of Manufacture:	2019 (Serial no: 3-007)
Date & Time (UTC):	3 February 2021 at 1138 hrs
Location:	MoD Area 7, Salisbury Plain, Chitterne, Wiltshire
Type of Flight:	Training
Persons on Board:	Crew - None Passengers - None
Injuries:	Crew - N/A Passengers - N/A
Nature of Damage:	Substantial damage to forward fuselage, front skids, both wings, propeller and rear boom
Commander's Licence:	Other
Commander's Age:	61 years
Commander's Flying Experience:	351 hours (of which 3 were on type) Last 90 days - 3 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During a training flight at a height of 400 ft agl the engine lost some power and the aircraft started to descend. The operator sent a command to limit the throttle but this did not resolve the issue. The autopilot was in a mode whereby the throttle was used to control airspeed and elevator used to control altitude. The loss of altitude caused the autopilot to pitch the unmanned aircraft nose-up until it stalled, entered a spin, and then hit the ground.

Following this accident the engine has been modified and the operator has changed their training and operational procedures to help mitigate the risk of recurrence.

History of the flight

The UAVE Prion Mk3 is a fixed-wing unmanned aircraft with a 3.8 m wingspan and a 45 kg maximum takeoff mass (Figure 1). It was being operated by the aircraft manufacturer on a training flight in a protected area of Salisbury Plain. The flight crew consisted of a Remote Pilot Station Operator (RPSO), a Safety Pilot and a Flight Operation Manager. The flight was conducted within Visual Line of Sight rules and the Safety Pilot was the PIC. The RPSO was sat inside a van equipped with a control station, while the Safety Pilot stood outside the van with a remote controller, in a position to be able to monitor both the aircraft and the displays inside the van. The Safety Pilot is able to take manual control within five seconds or less.

The takeoff was an automatic takeoff initiated by the RPSO. The UA climbed on a pre-programmed profile to a holding pattern height of 400 ft agl. After two minutes of normal flight the engine lost some power and the aircraft started to descend. The RPSO, after discussion with the Safety Pilot, decided to send an instruction to the aircraft to limit the throttle to 80% to see if that would resolve the problem. It did not and the aircraft continued to descend and slowed. The autopilot was set to Longitudinal Mode '0' which meant that it was controlling airspeed with throttle and altitude with elevator. As the aircraft started descending, due to the loss of power, the autopilot commanded nose-up elevator to regain the pre-programmed height. However, due to the loss of power this resulted in the aircraft decelerating and continuing its descent. Eventually, at a height of about 100 ft agl and about 480 m from its takeoff point the aircraft stalled, entered a spin, and then hit the ground.

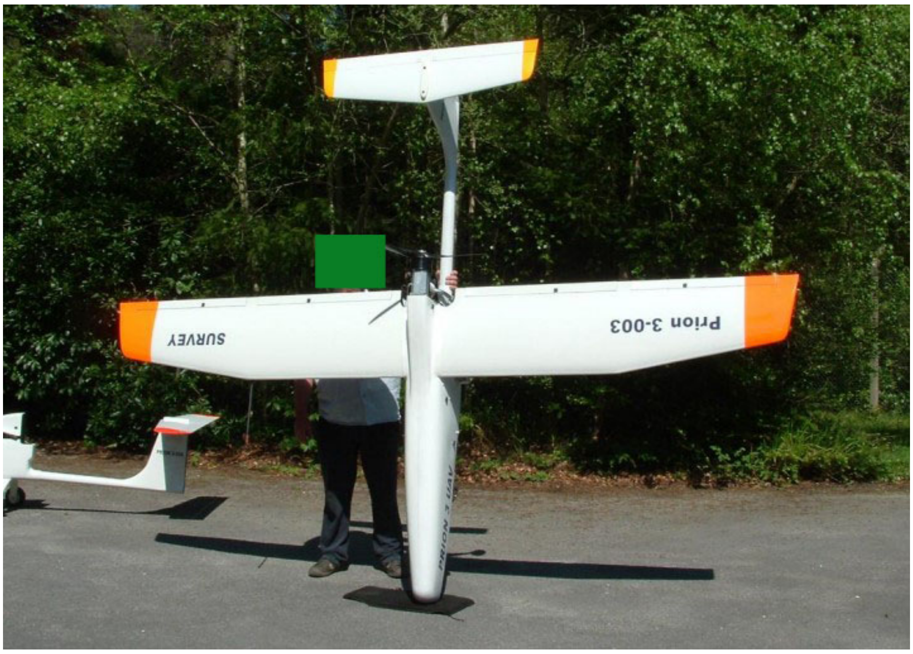

Figure 1
UAVE Prion Mk 3

Autopilot information

The autopilot has four longitudinal modes and these cannot be changed in-flight. Mode 0 is the default mode which uses throttle to control airspeed and elevator to control altitude. Modes 1 to 3 are airspeed modes which use elevator to control airspeed and throttle to control altitude. Mode 1 is the standard airspeed mode, whereas modes 2 and 3 allow the throttle to be fixed at 100% or 5% respectively while allowing the elevator to manage airspeed in a under-speed or over-speed situation. The autopilot will automatically switch from Mode 0 or 1 to 2 or 3 in the following situations:

- If the airspeed is lower than the minimum allowable value and the commanded throttle has reached 90% of full throttle, mode 0 or 1 will switch to mode 2. The throttle will increase to 100% and the autopilot will try to increase speed using nose-down elevator.

- If the airspeed has exceeded the commanded speed by a defined threshold and the throttle is at less than 5%, then mode 0 or 1 will switch to mode 3. The throttle will be set to 5% and the autopilot will try to reduce speed using nose-up elevator.

During the accident flight the RPSO restricted the commanded throttle to 80% to try and resolve the power issue, but this had the unintended consequence of preventing the autopilot from automatically switching from longitudinal mode 0 to mode 2. Therefore, the autopilot caused the aircraft to stall by increasingly demanding more nose-up elevator to regain the commanded height.

Powerplant examination

The loss of power was determined to have been caused by a loose spark plug cap. After the accident the engine was modified with a safety feature which provides additional security to ensure the plug cap is fitted correctly. This modification has been embodied fleet wide.

Additional information

The Safety Pilot reported that airspeed is constantly monitored and called out by the RPSO so that the Safety Pilot and Flight Operation Manager are aware. He explained that by the time they realised that their throttle instruction had not had the desired effect the aircraft was at 100 ft agl and there was no longer sufficient time for the Safety Pilot to take manual control and prevent the stall.

The default longitudinal autopilot mode is user definable, but once the aircraft is in flight the mode cannot be manually changed. The UAS manufacturer was of the opinion that in 99.9% of cases there was no need to manually change the mode in-flight. In the event of a stuck throttle the autopilot would still change to longitudinal mode 2 and prevent a stall, because the logic is based on the demanded throttle position rather than actual throttle position.

The UAS manufacturer is not planning to make any system changes but training exercises now reference this accident and their operational procedures have been amended to avoid limiting the autopilot's ability to command full throttle.

Conclusion

The UAS accident was the result of a combination of factors:

- The engine suffered a loss of power due to a loose spark plug cap.
- The attempt to resolve the power issue by limiting the throttle did not work.
- Limiting the throttle caused the autopilot to remain in a mode that would result in the autopilot stalling the UA.
- The system design did not permit the operator to change autopilot modes in-flight.
- There was insufficient time to take manual control when the airspeed started reducing towards the stall speed.

Safety actions

The UAS manufacturer has modified the engine on the fleet of Prion Mk3 aircraft with a safety feature which provides additional security that the spark plug cap is fitted correctly. As an operator they have also changed their training and operational procedures to help mitigate the risk of recurrence.

AAIB Record-Only Investigations

This section provides details of accidents and incidents which were not subject to a Field or full Correspondence Investigation.

They are wholly, or largely, based on information provided by the aircraft commander at the time of reporting and in some cases additional information from other sources.

The accuracy of the information provided cannot be assured.

Record-only investigations reviewed September - October 2021

16 Jul 21 **DA 40 D** **G-PLIP** Enstone Airport, Oxfordshire

The solo student pilot reported that as the aircraft landed it "went up and left". Full power was applied to initiate a go-around but the aircraft stalled and bounced on its right main landing gear before departing the runway to the left and coming to rest in a crop field.

19 Jul 21 **DHC-1 Chipmunk 22** **G-CERD** St Athan Airfield, Vale of Glamorgan

During takeoff the aircraft made an excursion from the runway which led to damage to the right landing gear. The aircraft landed safely and taxied back to hangar.

21 Jul 21 **Luscombe 8A** **G-BNIP** Roughay Farmstrip, Lower Upham, Hampshire

While landing at a farm strip the aircraft bounced and veered left, catching the left main wheel in tall crops and flipping the aircraft onto its back.

13 Aug 21 **DH82A Tiger Moth** **G-AXBW** Malshanger Estate Airstrip, Hampshire

After hand-swinging the propeller to start the engine, the engine rpm unexpectedly increased. As the pilot had omitted to chock the aircraft, it moved forwards and collided at low speed with two other Tiger Moths which were parked nearby. The pilot considered that the safety message is to ensure, in future, that the aircraft is chocked prior to start.

Note: The online version of this report was corrected prior to publication. Full details of the correction will be published in the January 2022 Bulletin.

23 Aug 21 **Skyranger Nynja** **G-SPLU** Sandy Airfield, Bedfordshire

Just prior to landing, the aircraft struck a tree which caused it to yaw and pitch down. The aircraft's landing gear suffered substantial damage during the subsequent hard touchdown.

24 Aug 21 **Quik GT450** **G-CEUF** Newtownards Airfield, County Down, Northern Ireland

A student pilot, with approximately 10 hrs experience, was practicing circuits with his instructor. The student was struggling with takeoff technique, so the instructor paused the circuits to provide additional instruction. During the subsequent takeoff roll the student applied more power to increase speed, in response to the instructor's guidance, but then lost directional control resulting in the wing contacting the ground and the aircraft rolling over.

Record-only investigations reviewed September - October 2021 cont

25 Aug 21 **Cessna 150E** **G-ASZB** Netherthorpe Aerodrome, Nottinghamshire

Following a bounced landing the pilot applied full power and pitched nose-up to initiate a go-around. However, there was some delay in retracting the flaps to the go-around position as the flap lever was difficult to move. The delay, and the nose high attitude, led to a decay in airspeed and the aircraft did not climb as expected. The aircraft touched down again and, still with full power applied, veered left off the grass runway. It subsequently struck, and came to rest against a neighbouring outbuilding.

26 Aug 21 **Magni M16C** **G-CITM** Blockmoor Farm, near Ely, Cambridgeshire

The gyroplane made a hard landing. Subsequent examination revealed that the nose landing gear leg had been pushed rearwards and the keel beam, aft of the propeller, was bent.

7 Sep 21 **Eurofox 912S(2)** **G-PECX** Beccles Aerodrome, Suffolk

As the aircraft accelerated for takeoff the pilot eased the stick forward to raise the tail wheel. The aircraft then swung to the left and left the runway. Power was maintained in an attempt to get airborne but the aircraft ground looped, breaking the right main gear and damaging the right wing tip and propeller.

8 Sep 21 **Reims Cessna FR172F** **G-DRAM** Glasgow Prestwick Airport

The landing gear did not lower normally and a manual lowering was carried out, but the right main gear remained unlocked. The aircraft touched down safely but slid off the right of the runway at low speed. A chafed hydraulic pipe had caused a total loss of fluid in the landing gear system.

8 Sep 21 **QuikR** **G-CGMZ** Eccles Newton Airfield, Berwickshire

After touchdown the aircraft began to decelerate and the brakes were applied about halfway along the grass runway. The pilot described applying a very small amount of brake pressure, following which the right brake appeared to engage before the left. The aircraft began skidding to the right, spun 270° and left the runway, coming to rest partly in a hedge with damage to the wing, front wheel, propeller and trike. The pilot sustained minor injuries.

9 Sep 21 **Jodel D11A** **G-BDBV** Seething Airfield, Norfolk

The pilot was practising circuit flying with another syndicate member onboard. The aircraft landed heavily to the right of the centreline, bounced, and veered to the right. He over-corrected to the left and the aircraft subsequently ground-looped. The landing gear then collapsed.

Record-only investigations reviewed September - October 2021 cont

11 Sep 21 **Tecnam P92-EA Echo-Super** **G-CBYZ** Middle Pymore Farm, Bridport, Dorset

The pilot completed all the pre-flight checks and took off from the farm airstrip with one passenger. As the aircraft left ground effect and started to climb, the engine "spluttered and stopped almost immediately". The pilot selected a field to the left, which had been in his Engine Failure After Takeoff (EFATO) pre-takeoff briefing, and made a forced landing. The aircraft suffered damage to the landing gear and the engine cowlings. No defects were found after the event.

16 Sep 21 **RAF 2000 GTX-SE** **G-CCEU** Mid Wales Airport, Welshpool , Powys

The aircraft landed in a left crosswind at an angle to the touchdown direction. As the wheels touched down the aircraft rolled right and then left. The pilot probably applied too much right roll input in correcting the left roll and, with the high residual rotor rpm, the thrust vector change was sufficient to roll the aircraft onto its right side.

19 Sep 21 **Quik GT450** **G-CIST** Perranporth Airfield, Cornwall

Whilst practising a cross-wind landing under instruction, at 10 ft agl the student did not round out. The instructor attempted to take control, but the student froze and the instructor was unable to prevent a hard landing. The microlight bounced into the air and then landed approximately 100 m further down the runway. It was substantially damaged; both crew sustained minor injuries.

21 Sep 21 **Reims Cessna F152** **G-SHBA** Denham Aerodrome, Buckinghamshire

The aircraft bounced on landing. The nosewheel collapsed on the second bounce and the propeller struck the runway.

27 Sep 21 **Piper PA-28-151** **G-BBXW** Gloucestershire Airport, Gloucestershire

The pilot was carrying out power checks, when the rotor wash of an EC135 taxiing behind the aircraft caused the left wing to lift, and the propeller and right wing tip to strike the ground.

28 Sep 21 **Cessna 152** **G-BSCZ** RAF Halton, Buckinghamshire

The aircraft suffered a heavy landing in turbulent weather which resulted in the nose landing gear collapsing and the aircraft veering off the runway.

Record-only investigations reviewed September - October 2021 cont

3 Oct 21 **Ikraus C42 FB100** **G-FROM** North Weald Airfield, Essex

On touching down, the aircraft veered off the concrete runway onto an area of soft grass. This caused the nose gear strut to collapse and the propeller tips to strike the ground. The engine was immediately shutdown, the aircraft was made safe and the two occupants exited the aircraft without injury. A nose wheel puncture was believed to have caused the aircraft to veer off the runway.

14 Oct 21 **Ikarus C42 FB80 Bravo** **G-IRED** Kittyhawk Aerodrome, East Sussex

The aircraft landed heavily on its nosewheel, causing the nose wheel to detach and damage to the propeller and fuselage.

14 Oct 21 **Ikarus C42 FB100 Bravo** **G-CIWP** Bodmin Airfield, Cornwall

The aircraft bounced on landing and the pilot pushed the stick forward, causing the nose wheel to make firm contact with the ground. The nose wheel detached, and the propeller and nose cowling were damaged.

14 Oct 21 **Rans S6-ES** **G-CDKE** Near Callington, Cornwall

Following a loss of engine oil pressure, the aircraft made a hard forced landing in a field, damaging the propeller and front fuselage.

15 Oct 21 **Skyranger Nynja** **G-NNJA** Broadmeadow Farm Airfield, near Hereford, Herefordshire

After discontinuing the first approach the pilot carried out another circuit to land on grass Runway 10, which had a slight southerly wind component. Touchdown was reported to have been too far along the runway for a successful landing. When the pilot applied the brakes the wheels locked and the aircraft skidded, striking an adjacent hedge and causing damage to the nose landing gear, propeller and engine area.

16 Oct 21 **Ikarus C42 FB100** **G-RTMY** Redhill Aerodrome, Surrey

Upon landing, the nose gear collapsed and the aircraft came to a halt on the grass runway.

Miscellaneous

This section contains Addenda, Corrections and a list of the ten most recent Aircraft Accident ('Formal') Reports published by the AAIB.

The complete reports can be downloaded from the AAIB website (www.aaib.gov.uk).

TEN MOST RECENTLY PUBLISHED FORMAL REPORTS ISSUED BY THE AIR ACCIDENTS INVESTIGATION BRANCH

1/2015 Airbus A319-131, G-EUOE
London Heathrow Airport
on 24 May 2013.

Published July 2015.

2/2015 Boeing B787-8, ET-AOP
London Heathrow Airport
on 12 July 2013.

Published August 2015.

3/2015 Eurocopter (Deutschland) EC135 T2+, G-SPAO
Glasgow City Centre, Scotland
on 29 November 2013.

Published October 2015.

1/2016 AS332 L2 Super Puma, G-WNSB
on approach to Sumburgh Airport
on 23 August 2013.

Published March 2016.

2/2016 Saab 2000, G-LGNO
approximately 7 nm east of Sumburgh Airport, Shetland
on 15 December 2014.

Published September 2016.

1/2017 Hawker Hunter T7, G-BXFI
near Shoreham Airport
on 22 August 2015.

Published March 2017.

1/2018 Sikorsky S-92A, G-WNSR
West Franklin wellhead platform, North Sea
on 28 December 2016.

Published March 2018.

2/2018 Boeing 737-86J, C-FWGH
Belfast International Airport
on 21 July 2017.

Published November 2018.

1/2020 Piper PA-46-310P Malibu, N264DB
22 nm north-north-west of Guernsey
on 21 January 2019.

Published March 2020.

1/2021 Airbus A321-211, G-POWN
London Gatwick Airport
on 26 February 2020.

Published May 2021.

Unabridged versions of all AAIB Formal Reports, published back to and including 1971, are available in full on the AAIB Website

http://www.aaib.gov.uk

GLOSSARY OF ABBREVIATIONS

aal	above airfield level
ACAS	Airborne Collision Avoidance System
ACARS	Automatic Communications And Reporting System
ADF	Automatic Direction Finding equipment
AFIS(O)	Aerodrome Flight Information Service (Officer)
agl	above ground level
AIC	Aeronautical Information Circular
amsl	above mean sea level
AOM	Aerodrome Operating Minima
APU	Auxiliary Power Unit
ASI	airspeed indicator
ATC(C)(O)	Air Traffic Control (Centre)(Officer)
ATIS	Automatic Terminal Information Service
ATPL	Airline Transport Pilot's Licence
BMAA	British Microlight Aircraft Association
BGA	British Gliding Association
BBAC	British Balloon and Airship Club
BHPA	British Hang Gliding & Paragliding Association
CAA	Civil Aviation Authority
CAVOK	Ceiling And Visibility OK (for VFR flight)
CAS	calibrated airspeed
cc	cubic centimetres
CG	Centre of Gravity
cm	centimetre(s)
CPL	Commercial Pilot's Licence
°C,F,M,T	Celsius, Fahrenheit, magnetic, true
CVR	Cockpit Voice Recorder
DFDR	Digital Flight Data Recorder
DME	Distance Measuring Equipment
EAS	equivalent airspeed
EASA	European Union Aviation Safety Agency
ECAM	Electronic Centralised Aircraft Monitoring
EGPWS	Enhanced GPWS
EGT	Exhaust Gas Temperature
EICAS	Engine Indication and Crew Alerting System
EPR	Engine Pressure Ratio
ETA	Estimated Time of Arrival
ETD	Estimated Time of Departure
FAA	Federal Aviation Administration (USA)
FIR	Flight Information Region
FL	Flight Level
ft	feet
ft/min	feet per minute
g	acceleration due to Earth's gravity
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
hrs	hours (clock time as in 1200 hrs)
HP	high pressure
hPa	hectopascal (equivalent unit to mb)
IAS	indicated airspeed
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
IP	Intermediate Pressure
IR	Instrument Rating
ISA	International Standard Atmosphere
kg	kilogram(s)
KCAS	knots calibrated airspeed
KIAS	knots indicated airspeed
KTAS	knots true airspeed
km	kilometre(s)
kt	knot(s)
lb	pound(s)
LP	low pressure
LAA	Light Aircraft Association
LDA	Landing Distance Available
LPC	Licence Proficiency Check
m	metre(s)
mb	millibar(s)
MDA	Minimum Descent Altitude
METAR	a timed aerodrome meteorological report
min	minutes
mm	millimetre(s)
mph	miles per hour
MTWA	Maximum Total Weight Authorised
N	Newtons
N_R	Main rotor rotation speed (rotorcraft)
N_g	Gas generator rotation speed (rotorcraft)
N_1	engine fan or LP compressor speed
NDB	Non-Directional radio Beacon
nm	nautical mile(s)
NOTAM	Notice to Airmen
OAT	Outside Air Temperature
OPC	Operator Proficiency Check
PAPI	Precision Approach Path Indicator
PF	Pilot Flying
PIC	Pilot in Command
PM	Pilot Monitoring
POH	Pilot's Operating Handbook
PPL	Private Pilot's Licence
psi	pounds per square inch
QFE	altimeter pressure setting to indicate height above aerodrome
QNH	altimeter pressure setting to indicate elevation amsl
RA	Resolution Advisory
RFFS	Rescue and Fire Fighting Service
rpm	revolutions per minute
RTF	radiotelephony
RVR	Runway Visual Range
SAR	Search and Rescue
SB	Service Bulletin
SSR	Secondary Surveillance Radar
TA	Traffic Advisory
TAF	Terminal Aerodrome Forecast
TAS	true airspeed
TAWS	Terrain Awareness and Warning System
TCAS	Traffic Collision Avoidance System
TODA	Takeoff Distance Available
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
USG	US gallons
UTC	Co-ordinated Universal Time (GMT)
V	Volt(s)
V_1	Takeoff decision speed
V_2	Takeoff safety speed
V_R	Rotation speed
V_{REF}	Reference airspeed (approach)
V_{NE}	Never Exceed airspeed
VASI	Visual Approach Slope Indicator
VFR	Visual Flight Rules
VHF	Very High Frequency
VMC	Visual Meteorological Conditions
VOR	VHF Omnidirectional radio Range

Air Accidents Investigation Branch